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# NUCLEAR SCIENCE ABSTRACTS

Vol. 2 No. 6

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Contents for March 30, 1949.


| Subject Category | Page |
|---|---|
| Absorption and Scattering of Radiation | 261 |
| Astrophysics | 262 |
| Atomic Power | 262 |
| Biological Effects of Radiation | 263 |
| Biology, General | 264 |
| Botany | 264 |
| Ceramics and Refractories | 265 |
| Chemistry, Analytical | 265 |
| Cosmic Radiation and Mesons | 266 |
| Fluorine and Fluorocarbons | 270 |
| Geophysics | 270 |
| Instruments | 270 |
| Isotopes | 271 |
| Mathematics | 271 |
| Metals and Metallurgy | 272 |
| Mineral Resources and Mineralogy | 273 |
| Neutrons | 273 |
| Nuclear Properties | 273 |
| Nuclear Transformation | 275 |
| Particle Accelerators | 276 |
| Petroleum Industry | 277 |
| Physics, General | 277 |
| Physics, Nuclear | 277 |
| Physics, Nuclear - Methods of Measuring | 277 |
| Physics, Theoretical | 280 |
| Radiation Chemistry | 281 |
| Radiation Sickness | 281 |
| Radioactivity | 281 |
| Radiotherapy | 284 |
| Rare Earths and Rare Earth Compounds | 286 |
| Scientific Research and Laboratories | 286 |
| Spectroscopy | 287 |
| Tracer Applications, Biology | 288 |
| Tracer Applications, Physics | 289 |
| Transuranic Elements | 289 |
| Uranium and Uranium Compounds | 290 |

## LOCATION LIST OF DECLASSIFIED AND UNCLASSIFIED DOCUMENTS

### Atomic Energy Commission Declassified Documents


| Document | Abstract No. | Page |
|---|---|---|
| AECD-2472 | 1235 | 276 |
| AECD-2473 | 1292 | 287 |
| AECD-2474 | 1186 | 265 |
| AECD-2475 | 1236 | 276 |
| AECD-2476 | 1179 | 264 |
| AECD-2477 | 1180 | 264 |
| AECD-2478 | 1301 | 289 |
| AECD-2479 | 1221 | 272 |
| AECD-2480 | 1207 | 270 |
| AECD-2481 | 1208 | 270 |


### Atomic Energy Commission Unclassified Documents


| | | |
|---|---|---|
| AECU-52 (ORNL-210) | 1282 | 286 |
| AECU-96 (K-2.31.2) | 1217 | 271 |
| AECU-97 (K-2.31.7) | 1218 | 271 |
| AECU-98 (K-2.31.4) | 1219 | 272 |
| AECU-99 (K-2.31.1) | 1220 | 272 |
| AECU-100 (K-339) | 1242 | 277 |
| AECU-101 (UCRL-262) | 1225 | 273 |
| AECU-102 (UCLA-6) | 1262 | 281 |
| AECU-103 (UCRL-121, Rev.) | 1165 | 261 |
| AECU-104 (NEPA-513) | 1183 | 265 |
| AECU-105 (UCRL-273) | 1263 | 281 |
| AECU-106 (UR-58) | 1302 | 290 |
| AECU-107 (UR-56) | 1264 | 281 |
| AECU-108 (CH-3888) | 1175 | 263 |
| AECU-109 (BNL-C-7 Appendix) | 1234 | 275 |
| AECU-110 (NEPA-465) | 1184 | 265 |
| AECU-111 (UCRL-250) | 1244 | 277 |
| AECU-112 (ANL-4100 Rev.) | 1176 | 263 |
| AECU-113 (UCRL-254) | 1293 | 288 |
| AECU-114 (UCRL-263) | 1294 | 288 |
| AECU-115 (UCRL-275) | 1265 | 281 |

## ABSORPTION AND SCATTERING OF RADIATION

1165 Collection of Range vs Energy and Rate of Energy Loss vs Energy Curves for Heavy Particles in Various Media by W A Aron, B G Hoffman and F C Williams. AECU-103 (UCRL-121 Rev.; 2nd Edition) Nov 1948 61p

Curves are given showing the range and rate of energy loss of protons, deuterons, and alpha particles of various energies in air, Al, Cu, Ag, and Pb. In addition, range curves of protons of various energies in H, He, Li, Be, B, C, N, and O are also given. An appendix contains energy loss computation tables. Tables list numerical values of proton ranges.

1166 88-Mev Gamma-Ray Cross Sections by James L Lawson Phys Rev 75 433-444 (1949) Feb 1

Total cross sections for 88-Mev $\gamma$-rays have been measured in 6 elements by absorption methods to a statistical accuracy of about 1.5%. The results expressed in $cm^2$/gram are 0.0107, 0.0252, 0.0471, 0.0665, 0.0909, and 0.0973 for the elements Be, Al, Cu, Sn, Pb, and U, respectively. Values appear generally lower than predictions of existing theory by a factor proportional to $Z^2$. Ratios of pair formation cross sections in different elements have been obtained in a few cases; these data can be used together with the total cross section to obtain non-pair cross sections (presumably Compton scattering). The cross section so obtained at 88 Mev agrees within the experimental accuracy of about 15% with the Klein-Nishina prediction for Compton scattering.

1167 Multiple Compton Scattering by W R Faust and M H Johnson Phys Rev 75 467-472 (1949) Feb 1

An experimental and theoretical investigation has been made of the $\gamma$-radiation in water produced by a uniform distribution of radioactive cobalt. The intensity and spectral distribution of the radiations are determined essentially by the multiple Compton scattering that takes place in the liquid. An approximate quantitative treatment is presented in which the multiple scattering is considered as a succession of steps which are the same for every emitted $\gamma$-ray. Although the method is quite crude, the numerical results both for the absolute counting rate of a submerged counter and for the effect of shielding around the counter are in close agreement with experiment.

1168 On the Penetration of Nucleons Through Heavy Nuclei by G C J Zwanikken Physica 14 530-541 (1948) Dec

The rate of loss of energy of a nucleon traversing a nucleus and the mechanism of star production are investigated on the basis of the meson type of interaction $e^{-Kr}/\kappa r$. The theoretical predictions obtained are compared with the available empirical data.

1169 On the Scattering of Protons in Hydrogen by C L Critchfield and D C Dodder Phys Rev 75 419-425 (1949) Feb 1

Results of the recent proton-proton scattering experiments at the University of Minnesota in which measurements were made at angles in the laboratory system from 8° to 45° using incident proton energies of from 2.4 to 3.5 Mev, are used to calculate phase shifts for the interaction. S-wave scattering is found which agrees with previous work in corresponding to the potential of an attractive rectangular well of radius $e^2/mc^2$ and depth 10.5 Mev (Hoisington and Thaxton, Phys Rev 56 1196 (1939)), or to a Yukawa-type potential with a meson of mass in the neighborhood of 300 electron masses. An anomaly which remains at the smaller angles is not removed by a careful treatment of the geometry of the scattering chamber, but is tentatively accounted for with a combination of repulsive p-wave scattering and a systematic experimental error of approximately 1%. The p-wave phase shifts are several times larger than those expected from a repulsive rectangular well of the same dimensions as the well for the s-wave scattering.

ABSORPTION AND SCATTERING OF RADIATION (continued)

1170 Particle Size Determination by Soft X-Ray Scattering by K L Yudowitch J Applied Phys 20 174-182 (1949) Feb

Small angle x-ray scattering measurements were made on samples of colloidal gold of radius from 50 to 400 A. Copper (1.54 A wavelength) and aluminum (8.32 A wavelength) radiations were used. The usual method of analysis is shown to be valid only for particles of radius less than 120 wave-lengths. Extension of the method to larger particles is achieved, giving improved electron microscope correlation. The use of longer wavelengths and optimum shaped slits is shown to reduce geometry errors sufficiently to give clear evidence of predicted intensity maxima. The first 3 secondary shape function maxima were observed. An additional interference maximum attributable to particle-to-particle interference was observed. The position and magnitude of this maximum are correctly predicted by an expression based on earlier fluid scattering theory.

1171 The Relative Stopping Power of Gases for Alpha Particles from Polonium by T N Hatfield, A E Lockenvitz and M Y Colby J Franklin Inst 247 133-136 (1949) Feb

The relative stopping power for $\alpha$-particles from polonium is determined for the following gases: $O_2$, $H_2$, $N_2$, $N_2O$, $CO_2$, $H_2S$, $C_3H_8$, $C_3H_6$ (cyclopropane), $C_3H_6$ (propylene), $C_4H_{10}$ (n-butane), $C_4H_{10}$ (iso-butane), $C_4H_8$ (butene-1), $C_4H_8$ (butene-2), $C_4H_8$ (iso-butene), $CCl_4$, $C_2H_5Cl$, $CCl_2F_2$, $C_2H_5I$. Three groups of isomers are included. The additive law is shown to hold for the gases for which the stopping power of the constituents is known and the law is used to calculate the stopping power of carbon, sulfur, chlorine, iodine, and fluorine from gases containing these elements.

ASTROPHYSICS

1172 Long-Period Oscillating Processes in Stars by D A Frank-Kamenetskiĭ Doklady Akad Nauk SSSR 61 231-234 (1948) July 11 (In Russian)

The author's theoretical study of thermokinetic oscillations (Diffusion and Heat Transfer in Chemical Kinetics, Moscow 1947, Chapter 10) is here applied to nuclear reactions taking place in stars. It is shown that the Critchfield-Bethe scheme Phys Rev 54 248 and 862 (1938)) of energy production in stars is in complete agreement with the requirements of the theory of thermokinetic effects. The calculations show that the stars perform slow oscillations, of a period of about $10^8$ years. Since the accepted age of the stars is of the order of $2 \times 10^9$ years, the number of completed cycles must be about 20, the individual differences depending on the stars' masses and the random variations in their chemical composition. The usual representation of stars as belonging to different stages of the same evolutionary sequence should be substituted by another viewing the stars as occupying different phases of an oscillatory process. The Critchfield-Bethe scheme postulates the following reactions: (1) $2H' \rightarrow H^2 \rightarrow He^3 + Q_1$; (2) $He^3 + He^4 \rightarrow Be^7 \rightarrow Li^7 \rightarrow 2He^4 + Q_2$.

ATOMIC POWER

1173 Future Developments in Nuclear Energy by Clark Goodman Nucleonics 4 No. 2 2-16 (1949) Feb

Future developments in nuclear energy, viewed primarily with respect to military applications, are discussed. The possibility of nuclear-powered aircraft and submarines is explored and several diagrams of artists' conceptions of such forms of transportation are shown. The problems involved in industrial utilization of nuclear power are described and various pertinent data on the present utilization of various sources of power and their relative efficiencies are tabulated. The cost of generating electrical power is also compared in tabular form with estimated costs of nuclear power and a chart of the estimated U. S. reserves of fissionable materials is also given.

ATOMIC POWER (continued)

1174 Some Problems in the Industrial Application of Atomic Energy by K H Kingdon Gen Elec Rev 51 No. 8 11-15 (1948) Aug

This is a general, non-technical discussion of the design and construction of nuclear reactors. Topics specifically discussed are industrial applications of nuclear reactors, specifications for reactor components, power generation, breeding of new fuel in a reactor, radioactive tracers in industry, personnel protection from radioactivity, and the security problem in connection with nuclear energy research.

BIOLOGICAL EFFECTS OF RADIATION

1175 Effects of $Sr^{89}$ and X-Radiation on Goats by Marquerite N Swift, C Ladd Prosser and Edward S Mika. AECU-108 (CH-3888) June 1946 74p

It seemed advisable to determine the toxicity and other effects of $Sr^{89}$ for goats in the hope that such information would provide a rational basis for extrapolation to man; such studies have already been made for mice, rats, rabbits and dogs. The study of x-radiation effects was included for comparison, and to provide a radiosensitivity correction factor applicable to $Sr^{89}$-toxicity data.

The 30-day $LD_{50}$ for intramuscularly-injected $Sr^{89}$ in goats appears to lie between 1.0 and 1.5 $\mu c/g$. The rate of excretion of $Sr^{89}$ in urine and feces and the per cent retained varies considerably, but over a range similar to that reported for the dog. Toxicity on the basis of body weight is thus the same or less in the goat than in the dog (30-day $LD_{50}$, 1.0 $\mu c/g$), and if the goat be assumed representative of the larger mammals, this indicates that the slope of the curve, relating animal size to $Sr^{89}$ toxicity, does change in the range 30-60 kg, and toxicity is clearly not a simple function of body weight. The clinical course and gross pathology following sublethal and lethal doses are in general similar to those observed in the dog. The pattern of hematological change is similar in goats and dogs, but the decrease in leucocyte count is noticeably less in nonsurvivors as well as in survivors in the former species.

The 30-day $LD_{50}$ for total-body x-irradiation in goats is about 350 r, a figure which approximates that obtained for the dog. The post x-irradiation syndrome is grossly indistinguishable from that following injection of $Sr^{89}$. There is some indication of a greater depression of the leucocyte count following x-irradiation. Blood coagulation times after x-irradiation were erratic and failed to show the definite rise characteristic of the x-irradiation, $Sr^{89}$, and $Pu^{239}$ syndrome in dogs.

1176 The Effect of Total-Body X-Irradiation on the Peripheral Blood and Blood-Forming Tissues of the Rat by S Phyllis Stearner, Eric L Simmons and Leon O Jacobson. AECU-112 (ANL-4100 Rev) Dec 1 1948 43p (Rev. of AECD-2022)

See abstract of AECD-2022 which appeared in Abstracts of Declassified Documents 2 346 (1948) June 30 and abstract of MDDC-1319 which appeared in Abstracts of Declassified Documents 1 723 (1947) Dec 20.

1177 Effect of Roentgen Rays upon Bartonella-Infected and Normal Rats by Dorothy Neuhof Naiman Amer J Roentgenol and Radium Therapy 61 95-97 (1949) Jan

Rats were given single continuous exposures of from 300 to 1000 r over the entire body in order to determine whether Bartonella muris infection affects the resistance of rats to roentgen rays. Although no definite conclusions could be drawn from the data as to the effect of Bartonella infection on survival time, it did appear that the infected rats were probably slightly less resistant than normal rats to irradiation. 2 tables.

BIOLOGICAL EFFECTS OF RADIATION (continued)

1178 A Method for the Simultaneous Exposure of Large Numbers of Animals to Single Dose High Intensity Total Body X-Ray Radiation by William H Chapman, Clyde R Sipe, D C Eltzholtz, Eugene P Cronkite, George H Lawrence and F W Chambers Jr. Naval Medical Research Institute Report No. 14 Aug 12 1948 10p (NP-605)

Methods of simultaneously irradiating 400 mice, 96 rats, 48 guinea pigs, 14 rabbits, and 6 dogs are described. This is accomplished by disposing animals along a circle of one meter radius at the maximum point of radiation density from the angular beam of a 1000 KV, 3ma, X-ray tube. By this method the numerous extraneous factors which may influence the mortality of the irradiation illness are neutralized and controlled, placing the study of factors which may influence the lethality of radiation on a better statistical basis.

BIOLOGY, GENERAL

1179 Preliminary Observations of Uranium Metal on Wound Healing with Reference to Gas Formation by W F Neuman, Roberta Allen and B J Mulryan. AECD-2476 (UR-50) Jan 13 1949 Decl Feb 21 1949 5p

Small scale tests were conducted to determine whether uranium caused gas-formation when exposed to tissue fluid. In-vitro experiments and in-vivo experiments using rabbits were carried out. It is clear that uranium metal did not result in gas-formation when exposed to tissue fluids. The apparent absorption of gas in the in-vitro experiment probably resulted from the solution (as a bicarbonate complex) of some partially oxidized uranium. Clinically, if gas-formation is observed in wounds containing uranium metal, it appears justifiable to assume that bacterial contamination is responsible for the gas-formation.

1180 The Metabolic Effects of Uranium on the Yeast Cell by Aser Rothstein. AECD-2477 (UR-54) Jan 11 1949 Decl Feb 9 1949 18p Proposed for publication in J Pharmacal and Exptl Therap

In the present paper, the qualitative effects of uranium on yeast cells are described in some detail. On the basis of these effects, it is possible to make some general statements regarding the mechanism of action of uranium. Uranium inhibits the utilization of glucose under both anaerobic and aerobic conditions: no $CO_2$ is produced, no oxygen is consumed, no hexose is consumed. If uranium is added after the glucose, there is a delay before inhibition takes effect. If uranium is added prior to the glucose, no such lag occurs. Uranium inhibits not only the metabolism of glucose, but of fructose and galactose as well. In the case of galactose, cells which are adapted to this substrate are inhibited to a greater extent than are unadapted cells. The metabolism of stored glycogen is relatively unaffected by uranium as measured by either oxygen consumption or glycogen degradation. The same is true for the aerobic metabolism of alcohol or acetate, and for glycogen synthesis from alcohol. Uranium increases the rate of liberation of base by cells suspended in substrate free medium. Uranium apparently acts on one of the earliest steps in hexose metabolism, a step which occurs at the surface of the cell. Either the permeability of the cell to hexose is decreased, or an enzyme inhibition is involved. 21 references.

1181 The Metabolic Properties of the Fission Products and Actinide Elements by Joseph G Hamilton Revs Modern Physics 20 718-728 (1948) Oct

This article is based on AECD-2012. An abstract of the document appeared in Abstracts of Declassified Documents 2 340 (1948) June 30.

BOTANY

1182 An Isotope Effect in Photosynthesis by John W Weigl and M Calvin J Chem Phys 17 210 (1949) Feb

This article is based on AECU-55. An abstract of the document has been listed in Nuclear Science Abstracts as abstract No. II-412.

## CERAMICS AND REFRACTORIES

1183 Report on Tantalum Carbide by Raymond E. Tate. AECU-104 (NEPA-513) Apr 20 1948 29p

This report summarizes for tantalum carbide the available information on the physical properties, chemical properties, fabrication data, preparation, analysis, equilibrium studies with other elements and compounds, and changes in properties upon exposure to radiation. Many gaps in the information occur because comparatively little work has been done on the compound. 14 references.

1184 Report on Tungsten Carbide by E L Reed. AECU-110 (NEPA-465) Mar 31 1948 68p

The report consists primarily of a listing of the physical and chemical properties of tungsten carbide materials, $W_2C$, WC and cobalt-cemented WC. Available data concerning the preparation and properties of the compounds $WTaC_2$ and $WTiC_2$ have been included. Information is also given on fabrication data, nuclear data, equilibrium studies with other elements and compounds, and changes in properties upon exposure to radiation for these compounds.

1185 Summary Report on Fundamental Studies of Ceramic Materials by J F Lynch, H Z Schofield and C R Austin. Battelle Memorial Institute (Office of Naval Research Contract) Oct 1947 49p (NP-607)

The investigation presents data on the properties of specific ceramic materials to assist in the evaluation of the potentialities of such materials, and to provide information which will be helpful to suppliers of these materials for use in gas turbine and jet propulsion devices. In the evaluation of ceramic materials for use in these devices, a number of factors were considered. The following appeared to be of primary interest: strength and creep properties at elevated temperatures, resistance to thermal shock, and weight per unit volume. In view of the properties required, the conventional ceramic bodies, which are bonded with a glassy phase, did not appear to be suitable from a fundamental standpoint, in that intercrystalline lubrication by the glass phase might defeat the desired objective. Pure crystalline bodies, therefore, seemed to offer promise. The single-component materials of relatively pure alumina, beryllia, or zircon were therefore selected for this investigation. The physical character of the raw ceramic materials, fabrication methods, and burning time and temperature on the physical, mechanical, and mineralogical properties of the respective bodies have been determined.

## CHEMISTRY, ANALYTICAL

1186 A Sensitive Flow-Type Glass Electrode by Martin Kuna. AECD-2474 Jan 19 1949 Decl Feb 18 1949 4p

A sensitive flow-type glass electrode with a small volume was needed for continuous pH measurement of eluates from ion-exchange columns. The Beckman flow-type electrode was not sensitive enough and the volume of the cell was 2 ml. A flow-type chamber was fabricated by using the Beckman 290 glass electrode, 2mm capillary tubing for the fluid flow, 1 mm capillary tubing for the calomel electrode attachment, and 9 mm i.d. tubing for the cell. An asbestos plug was inserted in the tubing connecting the calomel electrode to prevent backflow. The glass electrode was cemented in place with Kronig's cement. The volume of the chamber was approximately 0.2 ml.

1187 Ion Exchange by J F Duncan and B A J Lister Quart Reviews 2 307-348 (1948)

The authors, on the staff of the Atomic Energy Research Establishment, Harwell, give here a review of the present state of the ion exchange chemistry and of the uses and applications of ion exchangers. A critical discussion of the more fundamental aspects of the subject is made. 168 references.

## COSMIC RADIATION AND MESONS

1188 Absorption of Penetrating Shower Primaries by John Tinlot and B Gregory Phys Rev 75 519-520 (1949) Feb 1 (Letter to the editor)

An experiment which was conducted to determine the absorption in lead and iron of the ionizing radiation producing penetrating showers is described. The data were taken at an altitude of 14,200 feet using an arrangement of six trays of counters in conjunction with a fast addition circuit (resolving time 1.4 sec) which was used to detect multiple coincidences. The rate of occurrence of the event studied (registered as a 4-counter coincidence) is shown as a function of absorber thickness. The results obtained are discussed.

1189 The Angular and Lateral Spread of Cosmic-Ray Showers by Jane Roberg and L W Nordheim Phys Rev 75 444-457 (1949) Feb 1

The mean square angular and lateral spreads in showers have been evaluated for electrons as well as photons as functions of their energy. Analytical expressions have been obtained for high and medium energies down to the critical shower energy. The calculations have been extended by numerical methods for air down to low energies (~4 Mev). Radiative effects and ionization losses were taken into account simultaneously for all energies, and it is believed that no factors of physical significance have been omitted.

1190 Correlation of Penetrating Showers with Air Showers by John Tinlot and B Gregory Phys Rev 75 520 (1949) Feb 1 (Letter to the editor)

The relationship between locally produced penetrating showers and air showers has been studied at an altitude of 14,200 feet, in conjunction with previous work (Phys Rev 75 519 (1949)). Two trays of counters ("extension trays") were placed at distances of 1.0 m and 2.5 m, respectively, from the axis of a penetrating shower detector. Tabulated data are given for the rate of the occurrence of air showers coincident with penetrating showers using lead and iron absorbing materials. From the results it is concluded that dense air showers do not contain single particles capable of producing penetrating showers. It is noted, however, that they may contain groups of penetrating particles, some of which may interact to produce nuclear events, since these would be rejected by the penetrating shower detector in these experiments.

1191 The Effect of an Electric Field on the Number of Nuclear Disintegrations Observed on Photographic Plates by P I Lukirskii and N A Perfilov Doklady Akad Nauk SSSR 61 257-258 (1948) July 11 (In Russian)

In a previous work (Doklady Akad Nauk SSSR 54 219 (1946)) the authors described a method for the determination of the mass of negative mesons from measurements on photographic emulsions, under the assumption that these particles, upon being captured by nuclei, determine disintegrations with a maximum probability corresponding to very slow mesons. In the present paper an experiment, made at 3250 m altitude, is described which proved that the observed disintegrations were caused by negatively charged particles. A flat electrode, placed in the center of a spherical condenser and charged to + 5000 volts, carried the photographic plate. The photographs taken under these conditions showed a considerably larger number of disintegrations than those taken in the absence of an electric field (119 against 59). Several of the radiating tracks obtained were used for the determination of the meson mass. In one instance the disintegration was interpreted as $M^- + {}_7N^{14} = {}_2He^4 + 4_1H^1 + 6_0n^1 + \Sigma E_{kin}$. Assuming that the energy of a neutron was equal to that of a proton, the calculation based on the lengths of the tracks gave for the mass of the negative meson the value 196.3 $m_e$.

1192 Emissions of Mesons in Cosmic Stars in Photographic Emulsions by Eric Pickup and Adair Morrison Phys Rev 75 686-687 (1949) Feb 15 (Letter to the editor)

Ilford C2, boron-, lithium-, and deuterium-loaded emulsions have been exposed to cosmic rays on trans-atlantic flights at an average height of 12,000—15,000 feet. Meson tracks have been recorded in all these emulsions and one such event was previously reported (Phys Rev 74 706 (1948)). The results obtained are discussed and a mosaic of photomicrographs showing a long range meson ejected in an Ilford C2, boron-loaded emulsion is shown.

COSMIC RADIATION AND MESONS (continued)

1193 A Model for Nuclear Capture of $\mu$-Mesons by Marschall N Rosenbluth Phys Rev 75 532 (1949) Feb 1 (Letter to the editor)

The properties of $\mu$-mesons have led Christy to suggest that most of the rest energy of such mesons, when stopped in a material, is carried off by a light particle which is emitted during the capture of such mesons from their K-orbits. An approximate quantitative study of the consequences of this model has been made and the probability distribution of excitation energies, which to a first approximation is independent of the details of the meso-nuclear interaction, is shown. In plotting the distribution it was assumed that: (a) the $\mu$-meson has a mass 210 times that of the electron, (b) the number of neutrons and protons in the original nucleus is equal, (c) the outgoing light particle has zero mass, (d) the momentum of the incident $\mu$-meson is neglected, and (e) the nuclear radius is given by $r_0 = 1.5 \times 10^{-13} A^{\frac{1}{3}}$cm. It is concluded that the emission of anything other than a neutron is highly improbable and that the most probable number of neutrons emitted is one. The prediction of neutron emission is in agreement with the experimental evidence (McClure and Groetzinger, Bull Amer Phys Soc 23 7, 20 (1948); Sard, Bull Amer Phys Soc 23 7, 13 (1948)), although the observed number of neutrons emitted per capture seems to be greater than predicted.

1194 The Nature of Narrow Atmospheric Showers by S A Kuchai and I L Rosenthal Doklady Akad Nauk SSSR 60 1523-1526 (1948) June 21 (In Russian)

Narrow showers were studied at 3860 m altitude with the double telescope described by Zatsepin and Eidus (Zhur Eksptl i Teoret Fiz 17 937 (1947)) and with a hodoscopic instrument recording the number of individual counters released during a coincidence above and below a filter. The curve obtained by the first method showed a maximum at a point corresponding to a 2 cm Pb filter; this proved the presence of light particles, probably photons, in the narrow showers studied. This interpretation was corroborated by the comparison of the absorptions in different materials, as well as by the observations made by using the hodoscopic method. In the case of a shower composed of heavy particles, an equal number of counters would be traversed above and below the 2 cm Pb filter; the actual experiments showed that only 20% of the showers were of this kind, i.e., neither absorbed nor multiplied. The general conclusion is that the narrow showers investigated consisted of light particles, presumably photons, generated by some process of a non-cascade character.

1195 Observations with Electron-Sensitive Plates Exposed to Cosmic Radiation, Part I, by R Brown, U Camerini, P H Fowler, H Muirhead, C F Powell and D M Ritson Nature 163 47-51 (1949) Jan 8 (See also Nuclear Science Abstract No. II-1068)

Some of the more important processes involving charged mesons, which can be observed when the new Kodak nuclear research emulsions are exposed to cosmic radiation, are described. Such plates which have been described by Berriman (Nature 162 992 (1948)), record the tracks of charged particles even at minimum ionization. The processes discussed include examples of disintegrations produced by $\pi$-particles and the decay of $\mu$-particles. In about 10% of the cases, the track of the particle produced by the $\mu$-meson has a length in the emulsion greater than 1,000$\mu$. By studying the Coulomb scattering of these particles in their passage through the emulsion, estimates of their energy were obtained which were used to obtain a calibration curve. The latter, which is applicable to the rate of energy loss of weakly ionizing particles, is used in the second part of the paper in which evidence for the existence of mesons of mass greater than the $\pi$-meson is presented.

1196 On the Positive Excess of the Cosmic Radiation by E Clementel and G Puppi Nuovo Cimento 5 529-534 (1948) Dec (In Italian)

The question of the positive excess in cosmic radiation is considered. In particular, the contributions due to the primary proton component in proton-proton collisions (which are assumed to take place with multiple meson emission) and to the asymmetry between positive and negative mesons (because of the Coulomb interaction between the target nucleus and the mesons) are discussed. Sufficiently accurate experimental results were not obtained with respect to the possible contribution caused by the remainder of the primary component which might be of appreciable magnitude at high altitudes.

COSMIC RADIATION AND MESONS (continued)

1197 Penetrating Particles in Extensive Atmospheric Showers by G T Zatsepin, S A Kuchai and I L Rosenthal Doklady Akad Nauk SSSR 61 47-49 (1948) July 1 (In Russian) (See also Nuclear Science Abstract No. I-1564)

The nature of the penetrating particles in the extensive showers was investigated at 3860 m altitude. The absorption follows an exponential law up to 24 cm Pb, then ceases. The particles which pass through thicker filters are probably mesons observed by Daudin (Ann Chim (Paris) 18 145 and 217 (1943)) or protons. Particles passing through 16 cm Pb were identified as high energy electrons. By applying Belen'kii's theory of the passage of showers through heavy elements, the energy of the electrons in question is found to exceed $1.5 \times 10^{10}$ ev. These considerations point to the existence of a cause of scattering in showers other than the Coulomb interaction. The estimation of the density of the meson stream gave the value 150-200 particles per $m^2$. This high density proves a genetic relationship between the extensive meson showers and the large cascade showers.

1198 Positive Mesons Produced by the 184-inch Berkeley Cyclotron by John Burfening, Eugene Gardner and C M G Lattes Phys Rev 75 382-387 (1949) Feb 1

This article is based on AECD-1928. An abstract of this document has been listed in Abstracts of Declassified Documents II 292 (1948) June 15.

1199 Pulses Produced in Two Ionization Chambers by Extensive Atmospheric Showers by L Razorenov and A Knyazev Doklady Akad Nauk SSSR 60 1531-1534 (1948) June 21 (In Russian)

Two spherical ionization chambers and 4 groups of counters recorded extensive showers photographically. It was found that, as a general rule, the coinciding pulses in 2 ionization chambers were of very unequal values. The analysis of the phenomenon on the basis of the experimental data obtained leads to the following interpretation: an extensive shower of sufficient density should produce equal pulses in both chambers; however if additional ionization takes place in one of the chambers the pulses are increased considerably; this additional effect can be ascribed (1) to heavy particles from nuclear fissions, or (2) to dense and narrow streams of relativistic particles crossing the chamber, or (3) to an explosive shower originating in the chamber's wall. This effect shows the inadequacy of the current theory of extensive showers.

1200 The Second Shower Maximum in Au, Hg and Pb by J Clay and W L Scheen Physica 14 489-494 (1948) Dec

From earlier experiments with ionization chambers it was found that a second shower maximum exists for Pb and is found at a depth of about 16 cm of Pb (Clay and Jonker, Physica 7 673 (1940)). This has been measured again for Pb as well as for Au and Hg with counters recording showers of at least 2 particles. The counter arrangement used was such as to enable distinguishing between particles having tracks at different angles. The showers with 3 or more and 4 or more particles were also recorded. Curves of the data for the 3 elements are shown. In all cases the second maximum, which could have been caused by "knock-on" electrons produced by mesons, was observed.

1201 Spectrum of Varitron Masses at 3250 m above Sea Level by A Alikhanian, A Weissenberg, V Kharitonov and M Daion Doklady Akad Nauk SSSR 60 1515-1518 (1948) June 21 (In Russian) (See also Nuclear Science Abstract No. II-98)

An account is given of the work done at 3250 m altitude during the summer months of 1946 and 1947. Some of the results have already been published in several articles, the most recent being Alikhanian, Alikhanov and Weissenberg, Zhur Eksptl i Teoret Fiz 18 301 (1948) March. In the present paper a description is given of the authors' method of cosmic-ray mass spectrometry, and the results are presented in curves and tables. The existence was established of numerous positive and negative particles ("varitrons") with masses ranging between about 100 $m_e$ ($m_e$ is the electron mass) and 20,000 $m_e$, including masses which should be attributed to protons. The following masses, in $m_e$, were observed: 110, 150, 210, 270, 350, 430, 550, 650, 820, 950, 1300, 1840, 2200, 3500, 8000, 20,000.

COSMIC RADIATION AND MESONS (continued)

1202 Varitron Mass Spectrum, II by A I Alikhanian, A I Alikhanov, V M Morozov and A V Khrimian Doklady Akad Nauk SSSR 61 35-38 (1948) July 1 (In Russian)

In a previous paper (Doklady Akad Nauk SSSR 58 No. 7 (1947)) the authors published varitron masses obtained from deviations of cosmic ray trajectories in a magnetic field. The ranges covered were from 1.2 to 5.6 cm Pb. In the present paper more accurate mass values are given for the same range interval, as well as values corresponding to a range exceeding 5.6 cm Pb. The numerous maxima on the distribution curves of the trajectory deviations (or particle momenta) correspond to individual varitron masses. The abrupt positive slope of a maximum shows the minimum momentum of a particle with a given mass; the position of this abrupt slope permits the determination of the particle's mass. An important interpretation is given to the fact that the negative slope of some of the maxima is abrupt too. An upper limit for the momentum can occur in cases where a particle of a given mass is generated through disintegration of a heavier particle stopped in air; the outcome of such a disintegration of a particle, under the conditions observed, must be the formation of 2 particles, one charged, and one neutral or a photon. A tentative mass determination is given for parent varitrons generating the observed particles.

1203 Varitrons in the Hard Component of Cosmic Rays by A Alikhanian, A Weissenberg, M Daion, V Kharitonov and A Konstantinov Doklady Akad Nauk SSSR 61 39-42 (1948) July 1 (In Russian)

Continuing the work described in Doklady Akad Nauk SSSR 60 No. 9 (1948), the authors determined the particle masses belonging to the hardest fraction of the varitron rays, which forms about 90% of the whole radiation studied. Masses between 100 and 1840 $m_e$ were identified on the distribution curves of the particle momenta, the maxima on these curves corresponding to different varitron masses. The fact that many of the maxima are very narrow is interpreted as an indication of the secondary character of the particles: they are generated in a process of disintegration of heavier varitrons.

1204 A Study of Pulses Produced by Cosmic Rays in Proportional Counters by M I Podgoretskiĭ and M N Shcherbakova Doklady Akad Nauk SSSR 60 1527-1529 (1948) June 21 (In Russian)

The relationship between narrow showers and nuclear disintegrations was studied at 3860 m altitude. The coincidences in the proportional counters were traced to strongly ionizing heavy particles. The hypothesis of isolated particles generating several heavy particles was eliminated in favor of the hypothesis correlating the heavy particles, or the component generating them, with the narrow showers. It was found that particle generation in aluminum was weaker than in lead, that the generating process was anisotropic, and that the generating stream amounted to approximately $\geq 0.5$ particles per $cm^2$ in 1 minute.

1205 The Transition Effect in Atmospheric Showers by T Asatiani and N Shostakovich Doklady Akad Nauk SSSR 61 239-241 (1948) July 11 (In Russian)

An attempt was made to observe a transition effect in the narrow atmospheric showers first described by Alikhanyan and Asatiani (J Physics USSR 9 55 and 175 (1945)). The negative results of the experiments (made at sea level) confirmed the view that the nature of these showers is substantially different from that of the Auger showers and that electrons or photons do not enter as a fundamental part into their composition.

1206 V-2 Cloud-Chamber Observation of a Multiply Charged Primary Cosmic Ray by S E Golian, C Y Johnson, E H Krause, M L Kuder, G J Perlow and C A Schroeder Phys Rev 75 524-525 (1949) Feb 1 (Letter to the editor)

A cloud chamber photograph taken in a V-2 rocket at a height of 145 km is shown. In particular, the track produced by a heavily ionizing particle, not associated with any observable shower is noted. From various considerations it is concluded that the track is due either to an $\alpha$-particle of energy

COSMIC RADIATION AND MESONS (continued)

greater than 400 Mev, or to a more highly charged nucleus of energy greater than a correspondingly higher minimum. It is also probable that the photographic results are produced by primary cosmic rays of greater charge and mass than the proton.

FLUORINE AND FLUOROCARBONS

1207 The Infrared and Raman Spectra of Chlorine Trifluoride by E A Jones, T F Parkinson and R B Murray. AECD-2480 (KLI-114) Jan 3 1949 Decl Feb 9 1949 2p Proposed for publication in J Chem Phys

The Raman spectrum of liquid chlorine trifluoride and the infrared absorption spectrum of the gas in the 2 to 25 $\mu$ region have been investigated. Material from two commercial sources was used. The results of both Raman and infrared measurements are tabulated. The presence of five Raman frequencies is surprising since the expected pyramidal or planar models should have four and three Raman active frequencies, respectively. These considerations suggest either an unsymmetrical form or more probably, association in the liquid state.

1208 The Infrared and Raman Spectra of Carbonyl Fluoride by Patricia J H Woltz and E A Jones. AECD-2481 (KLI-116) Jan 3 1949 Decl Feb 9 1949 2p Proposed for publication in J Chem Phys

This is a preliminary report on the investigation of the infrared and Raman spectra of carbonyl fluoride. The infrared spectrum of gaseous $F_2CO$ was recorded on a Perkin-Elmer Corporation Type 12-B infrared spectrometer. A NaCl prism was used to scan the 12$\mu$ to 15$\mu$ region. The measurements from 15$\mu$ to 25$\mu$ were made with a similar spectrometer having KBr optics. For the Raman spectrum measurements on liquid $F_2CO$, a specially designed Raman tube of fluorothene was used to contain the sample. The $F_2CO$ was maintained in the liquid state by blowing a stream of nitrogen, which had been passed through a coil immersed in liquid nitrogen, over the Raman tube. A Lane-Wells Spectrograph No. 40-A was employed for these measurements. A table lists the infrared bands and Raman lines observed to the present time. The molecule is taken to be planar, of the same type as $H_2CO$ and $Cl_2CO$. This model has six fundamental modes, all of which are Raman and infrared active.

GEOPHYSICS

1209 Erratum: Significance of the Radioactivity of Potassium in Geophysics. II by T Gráf Phys Rev 75 534 (1949) Feb 1 (Letter to the editor)

A correction of the author's previous article (Phys Rev 74 831 (1948)) is noted. See Nuclear Science Abstract I-1410.

INSTRUMENTS

1210 Dispersing Static by Radioactivity Forecast 11 No. 2, 48-50 and 53 (1949) Feb

Some of the methods of controlling and dispersing static electricity are discussed. Radioactive static eliminators or Ionotrons are described in some detail and diagrams illustrating the principle of operation are shown. The Ionotron makes use of a convenient source of $\alpha$-radiation which produces the desired effect as a result of the ionization produced in the air containing the static charge.

1211 A Positive-Replica Technique for Electron Microscopy by C M Schwartz, A E Austin and P M Weber J Applied Phys 20 202-205 (1949) Feb

A positive-replica technique for electron microscopy has been developed, which reproduces the contour variations of the specimen surface, and permits direct visual interpretation of elevation. The method utilizes 2 resins, each mutually insoluble in the solvent for the other, specifically, polyvinyl alcohol plus Formvar. Shadow casting of the Formvar positive replica enhances detail and highlights the areas in relief in the original surface. Examples are given, in particular, as applied to wear-test specimens.

ISOTOPES

1212 Natural Abundance Measurements on Germanium by R F Hibbs, J W Redmond, H R Gwinn and W D Harmon Phys Rev 75 533-534 (1949) Feb 1 (Letter to the editor)

This article is based on AECD-2393. An abstract of the document has been listed in Nuclear Science Abstracts as Abstract No. II-147.

1213 $O^{17}$ and $S^{36}$ in the Rotational Spectrum of OCS by W Low and C H Townes Phys Rev 75 529-530 (1949) Feb 1 (Letter to the editor)

Using a Stark modulation system (Hughes and Wilson, Phys Rev 71 562 (1947)) data has been obtained on the OCS spectrum. The transitions $J = 1 \rightarrow 2$ of $O^{16}C^{12}S^{36}$ and $O^{17}C^{12}S^{32}$ have been detected and the abundance and mass of $S^{36}$ appears to be zero, and there is some indication that the spin of $O^{17}$ is 1/2. Tabulated data of the observed lines and their relative intensities are given. From these figures and published frequencies for other isotopes the ratio of mass differences $(O^{17} - O^{16}/O^{18} - O^{17}) = 1.00420$ and $(S^{36} - S^{34}/S^{34} - S^{32}) = 1.001826$ are obtained. The ratios obtained for the sulfurs, combined with other measurements of $S^{32}$ and $S^{34}$ masses, allow a determination of the mass difference $S^{36} - S^{34} = 2.00055 \pm 0.0003$ and hence the hitherto unmeasured $S^{36}$ mass as 35.97834 $\pm$ 0.0004 m. u.

1214 Reports and Discussions on Isotopes, Institut Internationale de Chimie, Solvay Brussels, R Stoops, 1948 411p

The following topics are included in this report of the meeting of the Solvay Congress in September, 1947: the transuranic elements (with tables of the radioactive families with their properties), mass spectrum analysis, the relative abundance of isotopes, radioactive tracers and their applications, and some biochemical work with radiophosphorus.

1215 Table of Isotopes by G T Seaborg and I Perlman Revs Modern Phys 20 585-667 (1948) Oct

This article is based on AECU-14. An abstract of the document has been listed in Nuclear Science Abstracts as Abstract No. I-1838.

1216 Tritium, the Radioactive Isotope of Hydrogen by B V Aĭvazov and M B Neĭman Uspekhi Fiz Nauk 36 145-180 (1948) Oct (In Russian)

A general survey of literature on tritium is given covering such subjects as the history of its discovery and the methods of its isolation, its half-life and the energy of its $\beta$-radiation, the physical, chemical, and nuclear constants relative to tritium, the analytical methods for its determination, its applications as an indicator in chemistry and biology. 11 tables, 7 curves, 7 diagrams of instruments, 137 references.

MATHEMATICS

1217 Most Efficient Designs for Linear Experiments by N Heerema and C Daniel. AECU-96 (K-2.31.2; A-4736) July 29 1947 17p

The point distributions are derived which give best measure of slope or of an extrapolated value on a least squares line when one variable only is subject to error. For the most precise measure of slope, all points should be bunched at two locations as far apart as the rate of decrease of the precision of measurement will allow, and should be distributed in the ratio of the standard deviations of measurement. For the most precise measure of an extrapolated value, all points should be bunched at two locations as far apart as the rate of decrease of precision of measurement will allow, and should be distributed in the ratio of the standard deviations of measurement times the inverse ratio of the distances to the extrapolated point.

1218 Statistical Methods in Engineering by C Daniel. AECU-97 (K-2.31.7) Nov 3 1946 7p

Statistical methods are shown to be useful aids in interpreting engineering data. The discussion includes the handling of large masses of numerical data, the interpretation of scanty data, objective

MATHEMATICS (continued)

estimates of the precision of a number, unusually high precision, extrapolation, and the planning of tests and measurements.

1219 Tests of Normality by H H Stotler and C Daniel. AECU-98 (K-2.31.4) Oct 9 1946 8p

Many of the methods of statistics are valid only when the universe from which samples are drawn at random follows the so-called normal distribution law. It is often necessary to test whether a sample could have been drawn from such a population. The $\sqrt{b_1}$ test for skewness and the "a" test for kurtosis (Tests of Normality by R C Geary and E S Pearson, University Press, Cambridge, England, 1938) are discussed.

1220 Fitting a Straight Line by H H Stotler. AECU-99 (K-2.31.1) Sept 9 1946 25p

The report presents concise methods for fitting straight lines to engineering data. Methods for calculating the precision of the slope (and of extrapolated values) are also given.

METALS AND METALLURGY

1221 Founding of Beryllium by J H Jackson, J G Kura, M C Udy and L W Eastwood. AECD-2479 June 1948 Decl Feb 18 1949 45p

The success with which beryllium castings can be made in the foundry depends, to a great measure, upon how well certain difficulties attendant to the handling of this metal are overcome. These difficulties, not peculiar to beryllium alone but encountered in the handling of many commercial metals, include a high degree of reactivity with oxygen and nitrogen; this characteristic is accentuated by the high pouring temperatures of 2600-3000°F, and results in the formation of dross which, if carried over to the mold, can produce serious casting defects. Another characteristic of the metal is that it is very weak and brittle at high temperatures and tends to crack easily when hot. Its low ductility when cold can also result in cracks, if the normal contraction of the casting is restrained during cooling. Finally, and perhaps the greatest difficulty encountered, has been unsoundness resulting from gas evolution during solidification. Another characteristic of the metal which must be carefully considered, is the apparently extreme toxicity of the fumes evolved during melting and of the dust formed during machining, grinding, sawing, etc.

The present investigation concerns the proper handling of beryllium in the foundry. Techniques have been developed which will permit the production of consistently sound beryllium castings from heats weighing up to 80 pounds and limited in size only the the melting equipment available for this particular operation. Recommendations are given for the melting and casting of beryllium based upon observations made in the course of the experimental work.

1222 Spectrographic Determination of Columbium and Tantalum by P Herman Spectrochim Acta 3 389-396 (1948) Sept 1 (In French)

The known chemical methods for the quantitative determination of columbium and tantalum in minerals and alloys are complicated and inaccurate. A spectrographic method was devised which consists in a microphotometric comparison of pairs of lines on a photographic plate. A mixture of $Cb_2O_5$ and $Ta_2O_5$ (containing small amounts of $SiO_2$, $SnO_2$, and $TiO_2$), prepared from the substance to be analyzed by heating with $KHSO_4$, was placed in the graphite crucible of the cathode; less than 0.02 was sufficient. The anode was a graphite cone, and the arc was produced by a d.c. of 10 amp (220 volt). The spectrograph used was a medium dispersion Hilger E-315 in combination with a step sector. The 2 line pairs employed were Cb 2716.69 - Ta 2714.68 and Cb 2927.82 - Ta 2933.67. Two dosage curves, corresponding to these line pairs, were constructed from the microphotometric measurements of the spectrograms which had been obtained from a series of mixtures of known ratios $Cb_2O_5/Ta_2O_5$. The errors do not exceed 1%. 7 references.

METALS AND METALLURGY (continued)

1223 A Vacuum Furnace for High-Temperature Microscopy by D G Nickols J Iron and Steel Inst 160 415-416 (1948) Dec

A vacuum furnace has been constructed to enable metal specimens to be kept under microscopic examination while at temperatures up to 950°C. It incorporates a mica observation window and gaskets of heat-resistant silicone rubber. Constructional details are given and future developments indicated.

MINERAL RESOURCES AND MINERALOGY

1224 Investigation of the Distribution of the Radioactive Elements in Rocks by the Photographic Method by J H H Poole and J W Bremner Nature 163 130-131 (1949) Jan 22 (See also Nuclear Science Abstract No. I-285)

A method is described for the microscopic study of the distribution of radioactive elements in rocks. A standard microscope slide of the rock to be examined is made, but the cover glass is omitted, so that the $\alpha$-rays from the rock can affect a nuclear plate placed in contact with the slide. Both slide and plate are placed in a specially constructed brass frame, in which they are held against three definite contacts, so that either slide or plate can be removed from the frame and replaced in the same position. The distribution of the tracks on the developed plate can be correlated with the rock minerals by replacing the rock slide on top of the plate. Polarized light can be used for the identification of the minerals in the usual manner. A composite photomicrograph of a Finland granite is given, showing numerous $\alpha$-ray tracks originating from some of the crystals. The nuclear plate was exposed to the rock slide for about 10 days. The absolute radioactivity of a crystal may be roughly estimated from the number of $\alpha$-particles emitted.

NEUTRONS

1225 The Scattering of High Energy Neutrons by Nuclei by S Fernbach, R Serber and T B Taylor. AECU-101 (UCRL-262) Dec 28 1948 12p

Experiments (L J Cook et als Phys Rev 75 7 (1949)) on the cross sections of nuclei for neutrons of about 90 Mev, indicate that the nuclei are partially transparent to high energy neutrons. This report shows that the results can be explained by using a nuclear radius of $1.37A^{1/3} \times 10^{-13}$ cm, a potential energy for the neutron in the nucleus of 31 Mev, and a mean free path for the neutron in nuclear matter of $4.5 \times 10^{-13}$ cm. This mean free path agrees with that estimated from the high energy n-p cross section, but the results are not sensitive to the choice of mean free path.

1226 Experiments on N-P Scattering with 90- and 40-Mev Neutrons by J Hadley, E Kelly, C Leith, E Segre, C Wiegand and H York Phys Rev 75 351-363 (1949) Feb 1

This article is based on AECD-2344. An abstract of the document has been listed in Nuclear Science Abstracts as Abstract No. I-1634.

NUCLEAR PROPERTIES

1227 Erratum: Line Shapes in Nuclear Paramagnetism by G E Pake and E M Purcell Phys Rev 75 534 (1949) Feb 1 (Letter to the editor)

Corrections are given for the equations appearing in a recent article by the authors (Phys Rev 74 1184 (1948)). See Nuclear Science Abstract I-1885.

1228 $H^3$ and the Mass of the Neutrino by W A Bowers and Nathan Rosen Phys Rev 75 523 (1949) Feb 1 (Letter to the editor)

Recent work on the half-life of tritium (Novick, Phys Rev 72 972 (1947)) and on its $\beta$-spectrum (Curran et als, Nature 162 302 (1948)) seems to remove the discrepancy noted by Konopinski (Phys Rev 72 518 (1947)), when considering the earlier data on tritium (Watts and Williams, Phys Rev 70 640 (1946); O'Neal and Goldhaber, Phys Rev 58 574 (1940)) if a zero rest mass is assumed for the neutrino. Using the more recent data, the values of $|M|^2ft$ obtained for both $H^3$ and $He^6$ were found to be of the same

NUCLEAR PROPERTIES (continued)

order of magnitude as the value for $He^6$ given by Konopinski. This result is in agreement with the conclusions of several workers (Curran et als, Nature 162 302 (1948); Cook et als, Phys Rev 73 1395 (1948)) concerning the neutrino mass based on the shapes of $\beta$-energy distribution curves near their upper limits.

1229 The Magnetic Moment of $Tl^{203}$ by W G Proctor Phys Rev 75 522-523 (1949) Feb 1 (Letter to the editor)

The ratios of the frequencies of the nuclear magnetic resonances of the 2 thallium isotopes to that of the proton and to each other have been measured with a nuclear induction apparatus made into a recording spectrometer which is similar in principle to one developed by Pound (Phys Rev 72 527 (1947)). However, perpendicular transmitter and receiver coils are used instead of a radiofrequency bridge, allowing determination of relative signs of nuclear moments. The ratios of the resonance frequencies in the same field were found to be $\nu(Tl^{203})/\nu(H^1) = 0.5714 \pm 0.0001$, $\nu(Tl^{205})/\nu(H^1) = 0.5770 \pm 0.0001$, $\nu(Tl^{203})/\nu(Tl^{205}) = 0.9903 \pm 0.0002$. The magnetic moments of the nuclei of both thallium isotopes were found to be positive, and their integrated resonance amplitudes were each consistent with a spin of 1/2, as given by spectroscopic data. If the magnetic moment of the proton is taken to be $(2.7928 \pm 0.0008)\ \mu_N$ and a correction for electronic diamagnetism is made, the following values are obtained: $\mu(Tl^{203}) = (1.614 \pm 0.003)\mu_N$, $\mu(Tl^{205}) = (1.629 \pm 0.003)\mu_N$.

1230 Nuclear Forces, Part III (Nuclear Models and Saturation Properties on Central Force Hypothesis), and Part IV (Non-Central and Non-Static Couplings) by Leon Rosenfeld. New York Interscience Publishing Company 1949 359p (See also Nuclear Science Abstract No. I-1444)

The author continues his development of the subject of nuclear forces in the following manner.

Part III. 1. Summary of nuclear models (descriptions of heavy and light nuclei, properties of a Fermi gas model, a table of nuclear models). 2. Nuclear multiplets (classification of nuclear states, stationary states of light nuclei, energy of nuclear states). 3. Saturation properties of nuclear forces (saturation requirements, stability of isobars). 4. Properties of heavy nuclei (mass-defects and heavy nuclei, standard heavy nuclei to second approximation, penetration of fast nucleons into heavy nuclei). 5. Collective nuclear models ($\alpha$-particle models, resonating group structure). 6. Properties of light nuclei (three-nucleon systems, binding energy of light nuclei).

Part IV. General types of non-central and non-static forces (empirical evidence, nuclear interactions, couplings in meson theory). 2. Non-central couplings and two-nucleon systems (the Rarita-Schwinger theory, meson theories with cut-off, mixed theory). 3. Non-central couplings and properties of heavier nuclei (fine structure of nuclear levels, fine structure of $He^5$, $Li^5$ and $Li^7$).

Appendices. 1. Allowed $\beta$-transitions. 2. Electromagnetic properties of nuclei. 3. Strong coupling theory of nuclear forces.

1231 Nuclear Gyromagnetic Ratios of $Be^9$, $Rb^{85}$, $Rb^{87}$, and $Cs^{133}$ by John R Zimmerman and Dudley Williams Phys Rev 75 699 (1949) Feb 15 (Letter to the editor)

Using the super-regenerative oscillator techniques described in recent notes (Phys Rev 74 1885 (1948); 75 198 (1949)), magnetic resonance absorption by the nuclei $Be^9$, $Rb^{85}$, $Rb^{87}$, and $Cs^{133}$ in aqueous solutions of salts has been observed. Preliminary results for the gyromagnetic ratios and magnetic moments of these nuclei are tabulated below:

| Nucleus | Gyromagnetic ratio g | Spin | Magnetic moment $\mu$ |
|---|---|---|---|
| $Be^9$ | 0.783 | — | — |
| $Rb^{85}$ | 0.536 | 5/2 | 1.34 |
| $Rb^{87}$ | 1.83 | 3/2 | 2.74 |
| $Cs^{133}$ | 0.734 | 7/2 | 2.57 |

NUCLEAR PROPERTIES (continued)

These values are in fair agreement with previous results obtained by molecular beam methods (Kusch, Millman, and Rabi, Phys Rev 55 666 (1939); 55 1176 (1939); Kusch and Millman, Phys Rev 56 527 (1939)).

1232 Special Zones in the System of Nuclei by M A Levitskaya Doklady Akad Nauk SSSR 61 55-58 (1948) July 1 (In Russian)

By "special zones" the author designates those regions in the periodic system where the cases with an odd Z contain each 2 isotopes. They comprise the Z intervals: 1-7, 16-21, 28-38, 46-52, 60-64, and 70-82. An explanation of this situation is suggested based on the assumption of different neutron levels in the nucleus. The appearance of a second isotope in an odd-Z case is determined by a transition of neutrons from a higher to a lower level in the preceding even-Z case. Another effect of such transitions is the branching of the lines of successive addition of protons and neutrons in the process of building-up of elements of increasing atomic number.

1233 Study of Phase Transitions by Means of Nuclear Magnetic Resonance Phenomena by Nelson L Alpert Phys Rev 75 398-410 (1949) Feb 1

This article is based on MIT Research Laboratory of Electronics Technical Report No. 76. An abstract of the report appeared in Nuclear Science Abstracts as abstract No. I-1881.

NUCLEAR TRANSFORMATION

1234 Appendix to Conference on the Chemical Effects of Nuclear Transformations (Hot Atom Chemistry) August 19-20 1948. AECU-109 (BNL-C-7 Appendix) nd 17p (See also AECU-50)

This appendix to AECU-50 (BNL-C-7) consists of the paper "The Dissociation of Ethyl Bromide by Neutron Capture", by Sol Wexler and T. H. Davies.

## PARTICLE ACCELERATORS

1235 Instrumentation for Nuclear Studies with Externally Focused Deuteron Beam from Ten Mev Cyclotron by B R Curtis, J L Fowler and L Rosen. AECD-2472 (LADC-603) nd Decl Feb 18 1949 23p Proposed for publication in Phys Rev

A beam of ten Mev deuterons of about 1/2 $\mu$a has been focused on an area 1/4 inch in diameter at the center of a two ft diameter reaction chamber 15 ft away from the cyclotron. In the center of the reaction chamber, a gas target is supported with side ports so constructed, that nuclear reaction products from the gas can be counted by a proportional counter mounted at the periphery of the chamber. The counter can be rotated through a Wilson seal to make any angle with the beam in the horizontal plane. At the exit of the reaction chamber, a Faraday cup is supported. This can be removed to allow the beam to pass between the poles of an analyzing magnet for energy measurements. Tests with charged particle detectors such as a proportional counter or photographic plates show the background to be sufficiently low to allow good resolution of the products from the D-D reactions. Using the D-D reaction as a neutron source, background neutrons above 11 Mev are only about ten per cent. However, the background neutrons above one Mev amount to about 25 times the neutrons from the D-D reactions.

1236 Focusing Ion Beams in High Gradient Tubes by J L McKibben. AECD-2475 (LADC-604) nd Decl Feb 21 1949 7p Proposed for publication in Rev Sci Instruments

The focusing potentials for ion beams have been calculated for a simple arrangement. The only important lens present, in tubes having uniform field, is shown to be the convergent field at the entrance to the accelerating field. Results are plotted and mathematically expressed. Magnification of the focal spot over the ion source exit is also calculated.

1237 Correction and Addendum: Scattering of Particles by the Gas in a Synchrotron by Nelson M Blachman and Ernest D Courant Phys Rev 75 315 (1949) Jan 15 (Letter to the editor)

Several corrections and additions to an article appearing originally in Phys Rev 74 140 (1948) are given. The foregoing article appeared as abstract No. 597 in Nuclear Science Abstracts 1 No. 4 (1948) Aug 30.

1238 Phase Focusing with a Linear Acceleration and a Spiral Accelerator by W Dällenbach Ann Physik 3 89-100 (1948) Aug (In German)

Two systems of linear differential equations are developed for the cases of the linear accelerator and the spiral accelerator (energy and kinematic relations) which permit calculations for arbitrary starting phases $\phi_s$ and $\phi_1$ of the synchronous or considered particle after the $n^{th}$ acceleration. Thus, the phase stability of the considered path portion can be determined. The phases of particles, whose starting phases $\phi_1$ lie within one of the ranges of the stable synchronous particle approach $\phi_s$ (as a focus) asymptotically with increasing number of accelerations ($\nu$). By numerical recursive solution of the 2 systems of differential equations for the 2 special cases of "slow" and "fast" particles, the range of the starting phases $\phi_1$, within which phase focusing takes place, is obtained. In the case of linear acceleration the synchronous particles are stable during the first half (increasing) of the positive half-wave, whereas in spiral acceleration this is true for the second half (decreasing). This is due to the fact that the ratio of the time interval between 2 successive accelerations of a particle to the corresponding time interval for the synchronous particles, decreases with increasing energy of the particle in the case of linear acceleration and increases in the case of spiral acceleration. In the linear accelerator, fast particles (electrons having velocities approaching the velocity of light) are not focused in phase. The focusing of the slow particles is effected by the variation of the velocity with the energy. In the case of the spiral accelerator, fast, as well as slow, particles are focused; the focusing is effected by the variation in the velocity with the energy for the slow particles and by the variation in the mass with the energy for the fast particles. Some results of the spiral-accelerator experiments have been published.

PARTICLE ACCELERATORS (continued)

1239 Some Experiments with a 14 Mev. Betasynchrotron by D J Allen-Williams and R K Appleyard Brit J Radiology 22 106-109 (1949) Feb

Preliminary experiments are described using a 14 Mev betasynchrotron at low dose-rates. The angular distribution of the high energy region of the $\gamma$-ray beam from an internal target is measured. A value for the absorption coefficient of the high energy photons in lead is given. The order of the neutron flux associated with high energy $\gamma$-ray beams is suggested. The measurement of the duration of the photon pulse from the synchrotron leads to a value for the radial spread of the electron beam in the synchrotron orbit.

1240 The Van De Graaff Generator by V W Lown Electronic Eng 21 No. 252 45-47 and 61 (1949) Feb

The design and construction details of the Van de Graaff generator are discussed and photographs of the various major components are shown. The various control and operation features are described and some of the applications of such machines are noted.

PETROLEUM INDUSTRY

1241 Apparatus and Method for Detecting Radiant Energy for Locating Subterranean Petroleum Deposits by Walter Armstrong, Washington, D. C. U. S. Patents Nos. 2,461,799 to 2,461,803 (1949) Feb 15

The 5 patents cover different models of an "apparatus for detecting and measuring radiant energy for locating subterranean petroleum deposits." The main part of the instrument is an "ionization chamber surrounded by a shield impervious to earthly ionizing radiation" except that coming from a certain direction. The models differ chiefly in the construction of the shield.

PHYSICS, GENERAL

1242 Bibliography on the Solubility of Argon, Carbon Dioxide, Helium and Nitrogen in Organic Liquids by Fred E Croxton. AECU-100 (K-339) Jan 25 1949 54p

The report consists of 137 references located from easily accessible reference works and indices covering the period 1907-1947. Arrangement is by authors with subject and references indexes included.

PHYSICS, NUCLEAR

1243 Dr. Seaborg and His Man-Made Atoms by William S Barton and Morton M Hunt Science Illustrated 4 No. 2, 46-48 and 83-85 (1949) Feb

The part played by G. T. Seaborg in the development of nuclear physics is described.

PHYSICS, NUCLEAR - METHODS OF MEASURING

1244 Pulse-Height Distribution Analyzer Using a Cathode Ray Tube by William E Glenn. AECU-111 (UCRL-250) Dec 8 1948 41p

The purpose of this study was to develop a pulse analyzer, a device which makes it possible to plot a graph of $\alpha$-particle energy vs number of particles emitted at that energy, which would be more reliable, accurate, and faster than the types currently used, and which would eliminate the drift of individual channels caused by a drift in bias or tube characteristics in that channel. By the use of a cathode-ray tube pulse-height selector, this last mentioned difficulty can be eliminated.

The pulse from the ionization chamber to be analyzed is shaped so that it has a flat top and is applied to the deflection electrode of the cathode-ray gun. The electron beam, which is normally off, is turned on at the peak of the pulse by a square pulse applied to the intensity grid of the electron gun. The beam is then turned on at a position corresponding to the height of the applied pulse. A series of anodes across the screen of the cathode-ray tube collect the current from the beam, and a series of

PHYSICS, NUCLEAR - METHODS OF MEASURING (continued)

mechanical registers count the number of times the beam strikes a given plate. This gives a count of the number of pulses which occur between two given pulse heights. Since the channel width and relative position is a function only of the physical width and position of the anodes in the tube, there can be no individual register drift. This type of pulse-height selection has the added advantages of being faster, and more easily stabilized than the conventional system using biased tubes. A schematic diagram of the apparatus is given.

1245 The Application of a Magnetic Lens Spectrometer to the Measurement of Gamma-Radiation from $Zn^{65}$ and $Co^{60}$ by Erling N Jensen, L Jackson Laslett and William W Pratt Phys Rev 75 458-466 (1949) Feb 1

This article is based on AECD-2286. An abstract of this document appeared in Nuclear Science Abstracts as abstract No. I-1150.

1246 Beta- and Gamma-Ray Spectroscopy--II by Gerald J Hine Nucleonics 4 No. 2 56-66 (1949) Feb

The experimental $\beta$-ray energy spectrums of some isotopes are compared with the results of Fermi's theory. The Fermi Diagram or Kurie Plot which directly compares measured and theoretical energy distributions and allows precise determinations of maximum $\beta$-ray energy and resolution of complex spectra is discussed. The use of the spectrometer to find $\gamma$-ray energies and intensities by internal and external conversion is also described. 19 references.

1247 Cadmium Sulfide as a Crystal Counter by G J Goldsmith and K Lark-Horovitz Phys Rev 75 526-527 (1949) Feb 1 (Letter to the editor)

Irregularly shaped single crystals of cadmium sulfide about 2 mm thick and a half a centimeter on a side have been investigated as $\alpha$-, $\beta$-, and $\gamma$-counters. Crystals which displayed a dark resistance of at least $10^9$ ohms and a light resistance of $10^6$ohms or less were found to be useful as counters. Plots of pulse height versus counting rate are shown for Po $\alpha$-particles, RaE $\beta$'s and $\gamma$'s from Ra, MsTh and $Co^{60}$. It was found that the pulse heights observed were a function of the applied voltage from 30 volts to about 200 volts--beyond that value the maximum pulse height remained constant but the crystal background increased considerably. In some crystals surface leakage or other conductive effects limited the voltage to around 300. Measurements of maximum pulse heights gave 12 mv for $\alpha$-particles, 6 mv for RaE $\beta$'s and about 2.5 mv for Ra $\gamma$'s.

1248 A Coincidence Scintillation Counter by G A Morton and K W Robinson Nucleonics 4 No. 2 25-29 (1949) Feb

A crystal diode differential coincidence circuit, using anthracene as the detector, is described. Coincidence circuits eliminate many of the disadvantages of scintillation counters due to the background of photo-multipliers. The coincidence scintillation counter described was found to perform satisfactorily in counting $\beta$-rays and fast neutrons.

1249 Counting Rate Meters versus Scalers by Arthur G Bousquet Nucleonics 4 No. 2 67-76 (1949) Feb

The characteristics of counting rate meters are discussed and compared with those of scaling circuit systems. The comparative advantages of these 2 instrument types used as radiation detector counting-rate indicators are discussed. 10 figures. 12 references.

1250 The Determination of the Energy of Alpha Particles with a Crystal Scintillation Counter by I Broser and H Kallmann Ann Physik 3 317-321 (1948) Aug (In German) (See also Nuclear Science Abstract No. II-970)

As a continuation of previous investigations experiments were performed with some fluorescent materials in order to obtain the relationship between the energy of single and numerous exciting $\alpha$-particles and the measured light intensity produced. It is shown that if single large CdS-Ag crystals

PHYSICS, NUCLEAR - METHODS OF MEASURING (continued)

are used as the material, the scintillations produced by single $\alpha$-particles are of approximately equal magnitude and their intensity is proportional to the $\alpha$-energy within the limits of the experimental accuracy (approximately 5%). Only a few specially produced and selected crystals produce such consistent and accurate results. Although only large crystals gave uniform results in the measurement of single scintillations, powdered-form materials such as ZnS gave good results in the case of measurements for several particles. A good linear relationship between the light intensity and the total absorbed energy of the particles was obtained.

1251 The Focusing of $\beta$-rays in a Prolate Spheroidal Magnetic Field by H O W Richardson Phil Mag 40 233-244 (1949) Feb

A discussion is given of the applicability to $\beta$-ray spectroscopy of the magnetic field between pole-faces which are hyperboloids of revolution. Trajectories of particles emitted from points on the axis of symmetry are computed by numerical integration of the relativistic equations of motion. The rays have the property of crossing over at 2 successive sites in the meridional plane of which the second could be arranged to lie close to the axis. The attainable resolving power seems to be similar to that of the semicircular spectrograph, while the solid angle of collection can be made as large as 8.5% of $4\pi$.

1252 Ionization Chambers by John A Victoreen Proc Inst Radio Engrs 37 189-199 (1949) Feb

The theory and construction of various types of ionization chambers are discussed; diagrams of the chamber constructions and associated circuits are shown.

1253 The Recording of Electron Tracks in Photographic Emulsions by R H Herz Phys Rev 75 478-485 (1949) Feb 1 (See also Nuclear Science Abstract I-662)

Four different methods of obtaining electron tracks in nuclear-track plates are described. Electron tracks have been produced by X-rays, by natural radioactive decay, by exposures in an electron microscope, and by feeble, induced radioactivity. A first attempt at establishing the range-energy relationship of electrons has been made from length measurements of electron tracks produced by heterogeneous and monochromatic x-rays at various kilovoltages and by monoenergetic electrons in an electron microscope. Some considerations are given on the sensitivity of the nuclear-track plate used in these experiments.

1254 Remarks on the Measurement of the Rest Masses and the Linear Dimensions of Ultra-Fast Particles by R Fürth Ann Physik 3 7-10 (1948) Aug

The general question investigated is the possibility of distinguishing between various types of ultra-fast particles on the basis of measurements of their masses and collision cross sections. ("Ultra-fast particles" are defined as particles having a rest energy small compared with their total energy.) It is shown that every such measurement can be reduced to measurements of the energies and impulses of the corresponding particles and that the inaccuracy of such a measurement is larger by a factor of $(e/mc^2)^2$ than the resulting inaccuracy in the energy and impulse measurements. From this it follows that it is impossible, in principle, to determine the rest masses and linear dimensions of the ultra-fast particles, even with respect to their order of magnitude.

1255 Stars in Photographic Emulsions Initiated by Alpha-Particles by Eugene Gardner Phys Rev 75 379-382 (1949) Feb 1

This article is based on AECD-2126. An abstract of the document has been listed in Nuclear Science Abstracts as abstract No. I-659.

PHYSICS, NUCLEAR - METHODS OF MEASURING (continued)

1256 Stars in Photographic Emulsions Initiated by Deuterons. Part I. Experimental by Eugene Gardner and Vincent Peterson Phys Rev 75 364-369 (1949) Feb 1

This article is based on MDDC-1676. An abstract of the document appeared in Abstracts of Declassified Documents 2 114 (1948) Mar 15.

1257 Stars in Photographic Emulsions Initiated by Deuterons, Part II. Theoretical by W Horning and L Baumhoff Phys Rev 75 370-382 (1949) Feb 1

This article is based on MDDC-1677. An abstract of the document appeared in Abstracts of Declassified Documents 2 114 (1948) Mar 15.

PHYSICS, THEORETICAL

1258 Canonical Transformations of the Hamiltonian in Meson Field Theory by K J Le Couteur and L Rosenfeld Phil Mag 40 151-157 (1949) Feb

In a recent note, Dyson (Phys Rev 72 929 (1948)) pointed out that by means of a certain canonical transformation it was possible to put the Hamiltonian of pseudoscalar meson field theory, and especially the coupling energy of this field with nucleons or leptons, into a simpler form, well-suited to bring out peculiar features of the theories of nuclear interaction and $\beta$-decay in this case, which would otherwise appear to be due to accidental reductions. Since Dyson does not go into any detail concerning these consequences of his transformation, these points are discussed in greater detail by the authors. For the scalar meson theory, Dyson gives another canonical transformation, which again simplifies the corresponding expression for the Hamiltonian. The authors also discuss this case and it is shown that, in contrast to the pseudoscalar case, Dyson's transformation for the scalar case is closely related to that introduced by Stueckelberg, and especially by Møller and Rosenfeld (Kgl Danske Videnskab Selskab 17, No. 8 (1940)) in order to separate the static part of the nuclear interactions. An ambiguity remaining in the latter transformation is demonstrated to have no physical meaning and as a result, the non-static interaction for the first order, for which a certain expression had been given by Rosenfeld (Kgl Danske Videnskab Selskab 32, No. 13 (1949)), can be made to cancel. By a similar argument, the analogous expression for the first order interaction in the pseudovector case can be considerably reduced.

1259 On the Cutting of a Particle Wave by Olivier Costa de Beauregard Compt Rend 227 1210-1212 (1948) Dec 8 (In French)

A wave associated with a particle falls on the negative face of a perfectly absorbent screen with an opening whose dimensions vary with time. This phenomenon of mixed diffraction and cutting is examined theoretically. Upon the assumption that the particle, whose spin is 1/2, obeys Dirac's equations, a solution is shown which is the general form of the emergent wave. This wave, developed in terms of plane and pseudo-plane waves, forms six families, the physical existence of which is proved, and which, in principle, could be studied experimentally. The intensities of the six wave families are given in the form of six probability integrals.

1260 On the Self-Energy of a Bound Electron by Norman M Kroll and Willis E Lamb, Jr. Phys Rev 75 388-398 (1949) Feb 1

The electromagnetic shift of the energy levels of a bound electron has been calculated on the basis of the usual formulation of relativistic quantum electrodynamics and positron theory. The theory gives a finite result of 1052 megacycles per second for the shift $2^2S_{\frac{1}{2}} - 2^2P_{\frac{1}{2}}$ in hydrogen, in close agreement with the non-relativistic calculation by Bethe.

PHYSICS, THEORETICAL (continued)

1261 Quantum Theory of Condensed Permanent Gases III The Equation of State of Liquids by J de Boer and R J Lunbeck Physica 14 520-529 (1948) Dec

The equation of state for liquified permanent and noble gases is discussed from the point of view of the law of corresponding states using molecular units, as developed in a previous paper (Physica 14 139, 149 (1948)). The deviations from the law of corresponding states, which are caused by quantum effects are evaluated theoretically, using the method of Kirkwood (Phys Rev 44 31 (1931)) and Slater (Phys Rev 38 237 (1937)). The results of the numerical calculations are compared with the experimental data. Tabulated data for He, $H_2$, $D_2$, Ne, A, Kr, and Xe are given.

RADIATION CHEMISTRY

1262 Studies on the Photochemistry of 2-Methyl-1,4-Naphthoquinone by Robert H Davis, Alice L Mathis, David R Howton, Herman Schneiderman and James F Mead. AECU-102 (UCLA-6) Jan 1 1949 15p

It is shown that the destruction of 2-methyl-1, 4-napthoquinone (MNQ) by light can be prevented by chloride or bromide ions. The protection of MNQ against photochemical decomposition afforded by chloride, bromide and possibly other ions is attributable to inactivation by these ions of the photon activated MNQ molecule. The most familiar analogous phenomena is the quenching of the ultraviolet fluorescence of quinine solutions by chloride ion.

RADIATION SICKNESS

1263 Opalescence of Serum after Total Body Radiation as a Prognostic Sign of Death by Robert L Rosenthal. AECU-105 (UCRL-273) Jan 14 1949 6p

During an investigation of the clotting reaction of blood after irradiation with 200 kv X-rays, the appearance of a marked opalescence was noted in the serum and plasma of rabbits which subsequently died a few days after exposure to a single lethal dose of total body irradiation. This opalescence appeared within 24 hours following exposure to radiation. In all cases, it disappeared completely 72 hours after exposure. A review of the literature failed to reveal any mention of this phenomenon. An attempt was made to find a correlation between varying intensities of the opalescence and the death rate of the rabbits. At present, there is no clear explanation of the mechanism by which radiation produces this opalescence. In view of its apparent relation to death, this phenomenon may not only provide a valuable early measurement of the effect of acute exposure to radiation, but may lead to further knowledge concerning the nature of radiation sickness and its lethal mechanisms.

RADIOACTIVITY

1264 The Half-Life of $Be^7$ by John F Bonner Jr. AECU-107 (UR-56) Jan 19 1949 8p

A highly active sample of $Be^7$ was prepared in the University of California 60-inch cyclotron by 20-Mev molecular proton bombardment of metallic lithium. The decay of a chemically-isolated portion of the sample was followed for over 150 days, and the half-life determined as 54.5 days.

1265 Nitrogen-12 by Luis W Alvarez. AECU-115 (UCRL-275) Jan 19 1949 12p

A radioactive substance with a very short half-life was observed when high energy protons from a linear accelerator were incident on carbon. This activity has been studied in some detail, and has been shown to be due to $N^{12}$. It is a rather interesting substance in that it has the shortest lifetime of any known beta emitter, and its positrons are more than three times as energetic as those from any other previously known radioactive isotope. $N^{12}$ is shown to have a half life of $12.5 \pm 1$ milliseconds, and a positron upper limit of $16.6 \pm 0.2$ Mev. It is produced by the reaction $C^{12}(p,n)N^{12}$, and has a threshold proton energy of 20.0 Mev. This indicates that $N^{12}$ is within about 200 Kev of being unstable against proton emission. The mass of $N^{12}$ is $12.0228 \pm 0.00015$, and the beta transition is allowed.

RADIOACTIVITY (continued)

1266 Beta-Decay of $Be^{10}$ and Theory of Beta-Decay by R E Marshak Phys Rev 75 513-515 (1949) Feb 1

If a spin change of 3 units is involved in the $Be^{10} \rightarrow B^{10}$ transition—as seems to be indicated at present—theoretical predictions of the minimum half-life lead to an essentially unique $\beta$-ray spectrum very different from the allowed shape. Measurement of this spectrum will provide a crucial test of existing theories of $\beta$-decay.

1267 The Beta-Spectrum of $Be^{10}$ by D J Hughes, C Eggler and C M Huddleston Phys Rev 75 515-518 (1949) Feb 1 (See also MDDC-1725)

Some results on the experimental $Be^{10}$ spectrum obtained by absorption methods are reported. The errors inherent in the absorption method are discussed in some detail and the influence of the strength of the sample on the difference between the true and the apparent $\beta$-end-point is noted. In order to obtain the $Be^{10}$ end point with the weak samples available, the absorption curve was extrapolated to the end point by comparison with an accurately determined $W^{185}$ absorption curve near the end point. In order to ascertain whether significant information on the spectrum shape could be obtained with weak samples, the shape of the $Be^{10}$ spectrum was compared with the spectra of various "standards" possessing well-known spectrum shapes. The comparison was made both by means of the shape of the $\beta$-absorption curve and of the $\beta$-momentum distribution in a cloud chamber. Careful absorption curves were run for a series of spectra, and the spectrum shapes were calculated from the following equation which was obtained by assuming that monoenergetic electrons are absorbed in a strictly linear manner: $(dN/dE) = R(d^2I/dR^2)(dR/dE)$. Here I is the counting rate at absorber thickness R, and E is the electron energy corresponding to the range R, and dN/dE (the $\beta$-spectrum) follows from the absorption curve directly. In each case the most probable energy ("maximum" of the curve) was about 100 Kev higher than for the true shape, although the end-point energy was correct. This shift was in the direction to be expected from the linear assumption. It was decided from these results that a simple method, and one of sufficient accuracy for obtaining an approximate $\beta$-spectrum, would be to obtain a spectrum by use of the equation given and then shift the points by 100 Kev (the value appropriate for an end point of 600 Kev; the "shift" increases slowly with end-point energy). As the absorption method in the simple form described gave consistent results, it was then applied to $Be^{10}$ and the curves obtained are shown.

1268 $\gamma$-Radiation from $Au^{198}$ by Kai Siegbahn and Arne Hedgran Phys Rev 75 523-524 (1949) Feb 1 (Letter to the editor)

The $\gamma$-radiation following the $\beta$-disintegration of $Au^{198}$ has been studied using a new double focusing spectrometer. The secondary electron spectrum obtained is shown. From their K photolines, it is estimated that the 157 and 207-Kev $\gamma$-rays previously reported by Levy and Greuling (Phys Rev 73 83 (1948)) have an upper limit to their intensity of 2% of that of the 411-Kev $\gamma$-ray. From a study of the primary $\beta$-spectrum the following values were obtained for the internal conversion coefficients of the K, L, and M lines of the 411-Kev radiation: $\alpha_K = 3.0\%$, $\alpha_L = 1.0\%$, $\alpha_M = 0.3\%$. In addition the energy of the $\gamma$-radiation was verified as $411.0 \pm 1$ Kev.

1269 An Investigation of Bremsstrahlung by Means of the Nuclear Isomerism of Indium by Walter C Miller and Bernard Waldman Phys Rev 75 425-432 (1949) Feb 1

The metastable state of $In^{115}$ has been used as a detector of a narrow energy band in the continuous x-ray spectrum produced by a monoenergetic electron beam on gold targets. The thin target x-ray isochromat ($h\nu = 1.04$ Mev) has been investigated in the neighborhood of the short wave-length limit. This isochromat is finite at the threshold and constant for at least 400 Kev. This is in agreement with Guth's theory (Phys Rev 59 325 (1941)) and verifies the assumption that the excitation of $In^{115*}$ is a line absorption. Both the thin target and thick target x-ray excitation curves for $In^{115}$ have been obtained in the region from 1.0 to 2.6 Mev. The thin target curve exhibits a step-like character from 1.0 to 1.9 Mev. The thick target curve below 2.0 Mev exhibits straight line segments as expected from

RADIOACTIVITY (continued)

the thin target curve, but above 2.0 Mev there are no straight line segments, in good agreement with the thin target data and theory. Activation levels have been found at 1.04 ± 0.02 Mev and at 1.42 ± 0.02 Mev. The overall cross section (per electron incident on a 34 mg/cm$^2$ gold target) is $10^{-34}$ cm$^2$ in the region of the threshold. Evidence is presented for the existence of a lower activation level between 0.8 and 0.9 Mev with an overall cross section (for a similar target) of the order of $10^{-36}$ cm$^2$.

1270 Magnetic Multipole Internal Conversion by I S Lowen and N Tralli Phys Rev 75 529 (1949) Feb 1 (Letter to the editor)

Curves for the ratio of the K to L shell internal conversion coefficients as a function of $Z^2/E$ have been obtained for the magnetic multipole case. These were obtained by using a rigorously correct expression (Drell, Bull Amer Phys Soc 23 18 (1948)) for the K shell, specialized for the case of non-relativistic energies for the magnetic multipole internal conversion and an analogously derived formula for the L shell internal conversion. The curves obtained are compared with those plotted from the Born approximation and it is noted that the Born approximation ratios for l = 1, 2 differ from the authors' approximation by less than 10% in the neighborhood of $10^5$ ev, and greater, $\gamma$-ray energy. It is concluded from the curves that caution is required in assuming equivalence of the 2 approximations for the ratio in this energy range, at least for Z-values of 35 or more. The L shell electric multipole conversion was calculated in the low energy region from the Dirac equation and it was found that additional contributions from the spin do not alter the value for this quantity as determined by Hebb and Nelson (Phys Rev 58 486 (1940)) from the Schrödinger theory.

1271 Mass Spectrometer Determination of the Half-Life of $Xe^{133}$ by J Macnamara, C B Collins and H G Thode Phys Rev 75 532-533 (1949) Feb 1 (Letter to the editor)

The half-life of $Xe^{133}$, determined from mass spectrometer abundance data, was found to be 5.271 ± 0.002 days. A mass spectrometer identification of $Xe^{133}$, together with abundance data for calculating its half-life, is further direct evidence for the mass assignment of the fission chain leading to 5-day xenon. The accurate half-life determinations possible from mass spectrometer abundance data for such isotopes as $Xe^{133}$ and $Kr^{85}$ suggest that gases containing these isotopes be used in checking the efficiency of counters for absolute $\beta$-counting.

1272 Maximum Positron to Negatron Ratio in the Decay of $Cl^{36}$ by Francis Johnston and John E Willard Phys Rev 75 528-529 (1949) Feb 1 (Letter to the editor)

Using more active samples of $Cl^{36}$ than those previously used in such studies (Grahame and Walke, Phys Rev 60 909 (1941)), the fraction of $\beta$-disintegrations which produce positrons has been determined as having a maximum value of approximately $3 \times 10^{-4}$. This value was determined on the basis of a lead absorption curve which is shown. The curve can be resolved into 2 components, one with a half-thickness of 300 mg/cm$^2$ corresponding to a 0.10-Mev $\gamma$-ray and the other with a half-thickness of 5.1 g/cm$^2$ corresponding to a 0.57-Mev $\gamma$-ray. These may both be due to bremsstrahlung radiation or they may be due to $\gamma$-rays emitted in a small fraction of the $\beta$-disintegrations or in decay by K-capture. It is possible, however, that the apparent 0.57-Mev component is the result of absorption of 0.501-Mev positron annihilation radiation. The extrapolated counting rate of 25 c/m of the apparent 0.57-Mev component was estimated to indicate a total of $11.6 \times 10^4$ $\gamma$-rays per minute emitted from the sample, or a total of $5.8 \times 10^4$ positrons per minute if this is annihilation radiation. The $\beta$-disintegration rate of the sample was estimated to be $1.9 \times 10^8$ disintegrations per minute.

1273 On the Geiger-Nuttall Relationship by Sukumar Biswas Phys Rev 75 530-532 (1949) Feb 1 (Letter to the editor)

The Geiger-Nuttall relation, $\log \lambda = a + bE$ has been modified and refined. It is shown that instead of plotting the isotopes of each radioactive series as is usually done, the relationship will be valid and the curve will be a smooth one only when isotopes of same atomic number are plotted, as suggested by

RADIOACTIVITY (continued)

Berthellot (J Phys et Radium 3 52 (1942)). The theoretical basis for the modification is outlined and the modified Geiger-Nuttall curve for polonium is shown. Similarly, smooth, modified Geiger-Nuttall curves have been obtained for all elements from Bi to Pu. From a critical study of isotopes in this region, probable $\alpha$- and $\beta$-activities as yet unknown have been predicted. The complete text will be published elsewhere.

1274 On the Numerical Calculation of the Internal Conversion in the K-Shell; the Electric Dipole Case by B A Griffith and J P Stanley Phys Rev 75 534-535 (1949) Feb 1 (Letter to the editor)

Some values of the coefficient $2I_k$ corresponding to the K-Shell in the electric dipole case have been calculated with the aid of a Fridén Calculating Machine (Model ST-10); Hulme's formula (Proc Roy Soc London 138 A 643 (1932)), in a simplified form, was used. The results, which were carried out to 5 significant digits, are quoted to 4 significant digits only.

1275 The Radiation Theories of Tomonaga, Schwinger, and Feynman by F J Dyson Phys Rev 75 486-502 (1949) Feb 1

A unified development of the subject of quantum electrodynamics is outlined, embodying the main features both of the Tomonaga-Schwinger and of the Feynman radiation theory. The theory is carried to a point further than that reached by these authors, in the discussion of higher order radiative reactions and vacuum polarization phenomena. However, the theory of these higher order processes is a program rather than a definitive theory, since no general proof of the convergence of these effects is attempted. The chief results obtained are (a) a demonstration of the equivalence of the Feynman and Schwinger theories, and (b) a considerable simplification of the procedure involved in applying the Schwinger theory to particlular problems, the simplification being the greater the more complicated the problem.

1276 Relativistic Formulation of the Quantum Theory of Radiation by S T Ma Phys Rev 75 535 (1949) Feb 1 (Letter to the editor)

A difficulty is noted which arises in connection with recent attempts to include time and the longitudinal components of the electromagnetic potential in the quantum theory of radiation by using 4 different kinds of photons. The temporal and longitudinal photons are found to differ considerably from the conventional transverse photons in their properties. Difficulties associated with normalization of the Hilbert vector representing a state of the electromagnetic field are also noted.

RADIOTHERAPY

1277 Alpha Ray Treatment of Dermatoses with Thorium X The External Application of Relatively Small Concentrations in Office Practice by Hermann Pinkus J Investigative Dermatol 12 61-67 (1949) Jan

Data from the treatment of 84 patients with thorium X chloride in 100 to 500 electrostatic units per cc of propyl alcohol indicate that it is an effective therapeutic adjuvant for various chronic superficial dermatoses, mainly of the inflammatory type. It was used for the conditions in which tar preparations or superficial X-ray therapy is commonly used. Its application was usually combined with any other local or internal therapy which were indicated, except X-ray treatment. Psoriasis, seborrheic dermatitis, various types of exzematous dermatitis, pruritis of the genital and anal area, lichen planus, lichen sclerosus et atrophicus, pigmented purpuric lichenoid dermatitis, keratoderma climacterium, chronic X-ray dermatitis, senile keratosis, seborrheic keratosis, and very superficial basal cell epithelioma were treated with varying degrees of success. The author thinks that it may be possible to assume that the use of thorium X in this strength is safe and does not lead to deleterious changes. 18 references.

RADIOTHERAPY (continued)

1278 Graves' Disease: Treatment with Radioiodine ($I^{131}$) by Mayo H Soley, Earl R Miller and Nadine Foreman J Clin Endocrinel 9 29-35 (1949) Jan

The results of treatment of 46 thyrotoxic patients with $I^{131}$ are presented. There were 42 satisfactory responses and 4 unsatisfactory responses. The latter are felt to be due to a conservative approach to therapy in the early phases of the study. Animal experimentation has been carried on to determine the effects of massive doses of $I^{131}$ upon tissues surrounding the thyroid, and the pathologic changes have been described. It has been found that upwards of 40 times the maximum therapeutic dose (in mc/kg) used in humans is required to produce serious damage in contiguous structures in mice and rabbits. The uptake of radioiodine by the thyroid in untreated Graves' disease was found to average 61%, whereas in the treated patient it averaged 16.6%. There appears to be a paradoxical lack of correlation between clinical response to treatment and the number of mc/gm delivered to the thyroid. $I^{131}$ in doses of 2 mc or more causes clinical and laboratory changes that point to thyroid tissue destruction. After therapy with $I^{131}$ exophthalmos progresses less than in patients treated by subtotal throidectomy and more than in patients treated with X-ray. Two patients in this series developed myxedema. $I^{131}$ in adequate dosage will destroy subtotally the hyperfunctioning thyroids in patients with Graves' disease and thereby produce usually a satisfactory remission of the symptoms and signs of hyperthyroidism.

1279 The Influence of Tumour Histology, Duration of Symptoms and Age of Patient on the Radiocurability of Cervix Tumours by M Gilmour, A Glücksmann and F G Spear Brit J Radiology 22 90-95 (1949) Feb

In a series of over 700 fully treated patients with epithelioma of the uterine cervix, more differentiated tumors than anaplastic ones of the same clinical stage responded favorably to treatment as measured by the 5-year symptom free survival rate. The usual treatment consisted of 3 insertions of radium (of the order of 110 mg, but varying per patient) for 22 hrs each at 1 and 2 week intervals. The incidence of differentiated tumors increased with age of patient. The clinical extent of the disease depended on the growth rate of the tumor and on the length of time it has been present. There was no correlation between survival rate and length of history per se. 4 tables.

1280 The Integral Dose Received from a Uniformly Distributed Radioactive Isotope by F Bush Brit J Radiology 22 96-105 (1949) Feb

Methods of calculation of the intergral dose received in simple geometrical bodies containing a uniformly distributed $\gamma$-ray emitting radioactive isotope are described, and a general relation between this dose and the volume, and the elongation of the body, deduced. These calculations have been extended to the case of a "patient", composed of cylinders and elliptical cylinders. A table is given, showing the integral dosage-rates in patients of different heights and weights from a uniformaly distributed $\gamma$-ray emitter. The effect of variation in the quantum energy of the emitted radiation on the integral dose is examined. An expression is found which gives the fraction of the energy due to $\beta$-particle emission which is lost from the surface of the patient or animal. This loss may be important in the case of small animals.

1281 Roentgen Therapy of Rheumatoid Spondylitis by Nathan M Spishakoff and B V A Low-Beer Calif Med 70 124-129 (1949) Feb

Results obtained in the treatment of 125 cases are analyzed. Practically every patient, regardless of the stage of the disease, was benefited. The best results were obtained when the radiation was given in three courses, separated by rest periods and homogeneously distributed along the spine. Although microscopic proof is lacking, the radiobiological effect probably is primary in the action on the lymphocytes, monocytes, and plasma cells infiltrating the synovial and subsynovial tissues. And while it is difficult to determine the effect on the metabolic activity of the fibroblasts, check roentgenograms have shown advancement of the ligamentous calcification and fusion of the articular processes in symptom-free patients.

## RARE EARTHS AND RARE EARTH COMPOUNDS

1282 Note on the Arc Spectrum of Element 61 by C Feldman. AECU-52 (ORNL-210) Nov 24 1948 6p

Addendum to Nuclear Science Abstract II-648. The other three lines mentioned by Harris, Yntema, and Hopkins as being common to Nd and Sm, and being more intense in the fractions intermediate between them (J Amer Chem Soc 48 1585 (1926)) were not found. Because of interference by $C_2$, CN, and possibly other bands, the presence or absence of spark lines of element 61 could not be established using the copper-spark technique.

## SCIENTIFIC RESEARCH AND LABORATORIES

1283 Atomic Energy Development, 1947-1948. Washington, Government Printing Office, 1948. 213p

This annual report tells of some of the aspects of the U. S. Atomic Energy Commission's program in the production of fissionable materials, the military application of nuclear power, and research activities in the physical and biological sciences. Other sections of the report are devoted to public and technical information activities, the security program, finance procedures, personnel policies, and patent policies. Appendixes include AEC regulations covering raw materials, source materials, production facilities, fissionable materials and patent compensation; isotope distribution tables and isotope-labeled compounds available; criteria for determining eligibility for personnel security clearance; correspondence concerning AEC labor policy; AEC employment policy; and executive orders pertaining to AEC.

1284 Impact of Radioactivity on Chemical Laboratory Techniques and Design by Paul C Tompkins and Henri A Levy Ind and Eng Chem 41 228-231 (1949) Feb

This article is based on AECD-1886. An abstract of the document was assigned the number MDDC-1719 and appeared in Abstracts of Declassified Documents 2 162 (1948) Mar 15.

1285 Laboratory for Preparation and Use of Radioactive Organic Compounds by C N Rice Ind and Eng Chem 41 244-248 (1949) Feb

A laboratory section for procedures making use of 1 mc or less of $\beta$- and $\gamma$-emitting substances is described. The aim has been to design a laboratory which can accommodate slightly greater amounts successfully. The isolated area set aside for this work includes laboratory, animal room, counting room, office, shower room, service room, and cleaning and storage space. Experimental operations at different levels of activity are separated in space. Surfaces are streamlined and as continuous as possible to simplify cleaning and decontamination procedures. Construction materials have been chosen for durability, stability toward solvent action, ease of cleaning, and ease and cheapness of replacement. Air conditioning gives controlled ventilation to protect personnel, to control direction of air movements, and to maintain detection apparatus under reproducible atmospheric conditions.

1286 Radiobiochemical Laboratories by William P Norris Ind and Eng Chem 41 231-232 (1949) Feb

Radiobiochemical laboratories, with few exceptions, may be considered, because of the nature of the work, to be concerned with levels of radioactivity not exceeding 10 mc. On a functional basis the operations involved may be considered to fall into five general categories: preparation of active materials in a form suitable for biological investigation, administration of active materials, care and housing of biological specimens containing radioactivity, preparation of samples for radioactivity measurements, and measurement of radioactivity. Ideally these operations should be carried out in separate rooms. A difficult problem is that of avoiding radioactive contamination, especially in working with animals where radioactive metabolic by-products are being eliminated. It seems advisable, therefore, to consider the installation of well-ventilated isolation areas for specimens which are eliminating appreciable quantities of radioactivity.

SCIENTIFIC RESEARCH AND LABORATORIES (continued)

1287 Radiochemistry Laboratories Introductory Remarks by J A Swartout Ind and Eng Chem 41 227-228 (1949) Feb

This article is based on AECD-1877. An abstract of the document was assigned the number MDDC-1716 and appeared in Abstracts of Declassified Documents 2 161 (1948) Mar 15.

1288 A Radioisotope Building by Paul C Tompkins Ind and Eng Chem 41 239-244 (1949) Feb

This article is based on AECD-1887. An abstract of the document was assigned the number MDDC-1771 and appeared in Abstracts of Declassified Documents 2 201 (1948) Mar 31.

1289 Remodeling a Laboratory for Radiochemical Instruction or Research by Henri A Levy Ind and Eng Chem 41 248-250 (1949) Feb

This article is based on AECD-1858. An abstract of the document appeared in Abstracts of Declassified Documents 2 268 (1948) May 15.

1290 Research with Low Levels of Radioactivity by J A Swartout Ind and Eng Chem 41 233-236 (1949) Feb

This article is based on AECD-1906. An abstract of the document was assigned the number MDDC-1717 and appeared in Abstracts of Declassified Documents 2 161 (1948) Mar 15.

1291 Semihot Laboratories by Nelson B Garden Ind and Eng Chem 41 237-238 (1949) Feb

Analyzing the problems in radioactive work with "1 curie level" leads to ambiguity, as this description leaves 2 uncertain factors in planning mechanical design. The degree of hazard depends upon the energy of radioactive radiation, and the weight or bulk of material involved could be very large or very small. A survey of the probable source of most radioactive materials makes it logical to expect gram quantities of material as a maximum, but micro quantities will be encountered most frequently in laboratories. Because of these small quantities, it appears possible to adopt a policy of constantly holding and transferring radioactive materials of practically every kind in closed containers or systems. Progress has been made in developing special chemical procedures and equipment to carry out this policy.

SPECTROSCOPY

1292 Instrumental and Doppler Broadening in the Fabry-Perot Interference Pattern of Close Doublets by P M Griffin and J R McNally Jr. AECD-2473 nd Decl Jan 28 1949 1p This document is an abstract; it is reproduced below in its entirety.

The intensity distribution in Fabry-Perot interference patterns, as a function of instrumental and Doppler broadening, is discussed. Merton's method (Proc Roy Soc Lond A 97 307 (1920)), in which the line shape is approximated by assuming that an exponential distribution of thermal velocities in the source gives rise to a Gaussian distribution of light in the interference fringe, was rejected as not being applicable to the Fabry-Perot instrument in agreement with the conclusions of Robertson (Can J Research 4 305 (1931)). Starting from the results of Saha (Phys Rev 10 782 (1917)) for a single line, an expression was developed for the intensity distribution due to a close doublet as a function of the temperature of the source, order of interference, reflection power of the interferometer plates, and the ratio of peak intensities of the two lines. This expression was applied to the green lines from a hypothetical source containing electromagnetically separated $Hg^{204}$ and $Hg^{202}$ as the principal impurity and investigated under the following conditions: source temperatures of 77 and 300 degrees Kelvin; reflection powers of 0.80, 0.85, and 0.90; orders of interference corresponding to plate separations of 1, 2, and 3 centimeters. From these data, conclusions are drawn concerning the maximum tolerable percentage of $Hg^{202}$ in a $Hg^{204}$ source, if the green line from this source is to be used as an acceptable standard of wave length.

## TRACER APPLICATIONS - BIOLOGY

1293 The Path of Carbon in Photosynthesis. IV. The Identity and Sequence of the Intermediates in Sucrose Synthesis by M Calvin and A A Benson. AECU-113 (UCRL-254) Dec 14 1948 15p

The synthesis of sucrose from $C^{14}O_2$ by green algae has been investigated and the intermediates separated by the method of paper chromatography. It is shown that sucrose is the first free sugar appearing during photosynthesis. It is apparently formed by condensation of the glucose-1-phosphate and a fructose phosphate. A series of radioautographs of paper chromatograms of extracts from plants which have photosynthesized for different periods of time has been prepared. The results indicate that 2-phosphoglyceric acid is the first product synthesized from $CO_2$ during photosynthesis.

1294 Chlorophyll and Photosynthesis by M Calvin and S Aronoff. AECU-114 (UCRL-263) Dec 30 1948 3p

Experiments designed to test whether chlorophyll transfers non-labile hydrogen during photosynthesis have been concluded. The experimental procedure consisted in the suspension of Chlorella algae in $D_2O$, followed by the exposure of a vessel to light for a time of such duration that the mole ratio of oxygen evolved as the result of photosynthesis to chlorophyll present was 20-1; identical runs without light were also made. The chlorophyll was then isolated, purified and analyzed for deuterium content. The procedure used was applicable only to non-labile hydrogen, since exchange with hydrogens capable of transfer would proceed to the same extent regardless of the presence or absence of light and the isolation and purification of the chlorophyll would result in a loss of all exchangeable deuterium by virtue of copious washing with ordinary water.

The results of the experiments were negative in character and indicate that (a) chlorophyll may act as a sensitizer rather than as a hydrogen transport agent, or (b) if it does not act as a hydrogen carrier it (1) functions via an enolizable hydrogen, or (2) the fraction of chlorophyll that is fairly active is small compared to the amount of material, or (3) the path of hydrogen from water to chlorophyll proceeds via a large reservior of non-exchangeable hydrogen.

1295 The Distribution in Rabbit Tissues of Intravenously Injected Iodine as Shown by the Radioisotope, I 130 by Walter Mann, William F Bale, Harold C Hodge and Stafford L Warren J Pharmacol and Exptl Therap 95 12-17 (1949) Jan

The distribution of intravenously-administered $I^{130}$ in rabbit thyroid, blood, muscle, kidney, lung, liver, spleen, and heart, up to 12 hours after injection, was measured. The total iodine present in these tissues was also determined chemically. The thyroid gland contained relatively high percentages of the injected dose. After 12 hours the $I^{130}$ concentration was more than 1000 times that in other tissues. From this work and the data of others, it is concluded that to produce maximal concentrations of radioiodine in the thyroid gland, the total dose of iodine ($I^{127}$) should be kept as small as possible.

1296 The Effect of Anesthetics on the Uptake of Radioactive Phosphorus by Human Erythrocytes by V Pertzoff and C L Gemmill J Pharmacol and Exptl Therap 95 106-115 (1949) Jan

The rate of uptake of radioactive phosphate ions by human erythrocytes is a variable. It varies from individual to individual and in the same individual from day to day. This change seems not to be a function of food intake. Sodium barbital decreases the rate of uptake of radioactive phosphate ions by the red blood cell. Ether has a retarding effect. Methadon (in very dilute solution) and urethane do not change the rate of uptake of phosphate ions by the red blood cell. It seems probable that the anesthetics which delay the uptake of phosphate are acting on an enzymatic process.

TRACER APPLICATIONS - BIOLOGY (continued)

1297 A Method of Estimating the Time at Which a Counting Rate Changes, Using a Geiger-Műller Counter by S B Osborn and H Payling Wright Brit J Radiology 22 110-116 (1949) Feb

A method is described, together with the necessary apparatus which permits the measurement, with reasonable accuracy, of a time interval terminated by a change in counting-rate of a Geiger-Műller counter. It has been successfully used in the measurement of the rate of flow of venous blood in the leg of human subjects, using radioactive sodium, $Na^{24}$. It is estimated that, as used for this purpose, a flow time of 6 secs can be measured to within 1 sec., and a flow time of 50 secs. to within about 3 secs; such uncertainties could be reduced in some other applications of the method.

1298 Studies in Percutaneous Absorption of Radioiodine by Otis B Miller and W A Selle J Investigative Dermatol 12 19-29 (1949) Jan

Methods demonstrating absorption of iodine from the skin with the use of $I^{131}$ (aqueous sodium iodide) are presented. Studies on human subjects indicate that iodine applied to the skin remains in the skin for several days, gradually disappearing either by absorption or by evaporation and other surface loss. The application of radioiodine to the skin of a pregnant animal results in marked concentration of the iodine not only in the thyroid gland but also in the gastric fluid of the fetus; approximately 70% of all the iodine present in the fetus is recoverable from the stomach. The distribution of radioactive iodine in various organs of the rabbit and guinea pig following percutaneous absorption is shown in a table.

1299 Use of Radioactive Phosphorus in Plant Nutritional Studies by R Scott Russell and R P Martin Nature 163 71-72 (1949) Jan 8

This is a preliminary report of work in progress to determine whether radiation damage is negligible at the concentrations necessary for tracer investigations. Young barley plants were treated with $P^{32}$ in the form of phosphate varying from 0.5 to 50 microcuries/liter of culture solution over periods of 4 to 6 days. The investigators feel that their findings show that radiation damage may be a much more serious hazard in tracer experiments than the literature had led them to expect. Significant radiation effects were observed when the level of $P^{32}$ is 10 microcuries/liter. It is pointed out that, since radiation injury is occasioned by the accumulation of $P^{32}$ within the plant, the level of tracer at which injury occurs will vary between experiments according to the rate of nutrient accumulation of of the plants, the level of the carrier, the age of the plant, and the duration of the experiment.

TRACER APPLICATIONS - PHYSICS

1300 Photo-Density Method of Determining the Relative Penetration of Diffused Sodium 24 Tracer into Glass by James R Johnson J Applied Phys 20 129-131 (1949) Feb

A photo-density method for the determination of diffusion of radioactive tracer is presented and compared in detail to a thin section analysis method. This method should be applicable to similar tracer problems such as metal diffusion studies. The proper analysis of an emulsion exposed by decaying $Na^{24}$ which had been allowed to diffuse into glass is given and the necessity for making and using an emulsion $\gamma$-curve for the tracer in this analysis is shown.

TRANSURANIC ELEMENTS

1301 The Spectra of the Heavy Elements by Frank S Tomkins and Mark Fred. AECD-2478 (ANL-FST-380) Dec 29 1948 Decl Jan 26 1949 29p

The spectrum lines of several heavy elements were measured in the region 2650-4370 A with a Baird three-meter spectrograph by the copper spark method (Fred et als, J Optical Soc Amer 37 279 (1947)). Tables are presented giving wave lengths accurate to the first decimal place and the intensity of the lines for Pa, Np, Pu, and Am. The most sensitive and distinctive lines in the region